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Editorial

Charges against the Petroleum Administration for War, made before a recent hearing in Los Angeles of an Assembly interim committee by a small group of perennial malcontents from the oil industry, will get scant support from either major or responsible independent elements in the industry. The consensus of opinion appears to be that the PAW is doing a good job despite handicaps for which it is in no way responsible.

Had the hearing not developed into a name-calling spree by this small but articulate oil group whose fetish is the law of capture, some pertinent facts might have been brought out and something constructive accomplished. There is a great contrast between a legislative hearing of this type and those held a few years ago in California by the able Congressional Cole Committee. Had the Assembly committee adhered to its original purpose, which was to develop ways and means for further stimulating California's production of crude oil, it might have assisted the industry's war program. The committee should have made it its business to obtain information about the forward steps that have been taken by the PAW in collaboration with the oil industry since Pearl Harbor and the further effort that is being made to develop additional production to meet increasing military and essential civilian demands. Instead, the committee heard, and the newspapers reported to their readers, that Ickes is attempting to foist an Atkinson Bill on the oil industry under the pretext of war necessity.

The facts about California's oil situation are pretty well known within the industry, but it may be well, nevertheless, to take stock and see just what has been accomplished despite materials and manpower shortages, and an OPA price ceiling on crude oil that taxes the ability of the producing companies to keep out of the red.

Reference to readily available statistics shows that crude oil output has been stepped up since our entrance into the war from approximately 630,000 barrels daily to 775,000 barrels daily, a gain of 23 per cent.

The total number of producing wells in California has increased 16 per cent since December, 1941, and at the end of September stood at 19,396 wells, an all-time high for this state.

Drilling of new California wells has been greatly accelerated this year due to PAW's success in persuading the War Production Board to raise the allocation of steel for the producing branch of the industry. It will be recalled that when the war broke out the WPB did not wish to allow **any** steel for drilling, so general was the belief that we had limitless reserves of oil and that production could be increased as much as desired merely by turning some valves. Finally WPB was persuaded to allot 60 per cent of the steel used in 1941 and this was the basis of Conservation Order M-68, now PAO-11, the 40-acre spacing order. These spacing restrictions have been greatly relaxed and special exceptions have been granted in certain local conditions as more steel has become available. As a result California operators will drill twice as many wells this year as they did last.

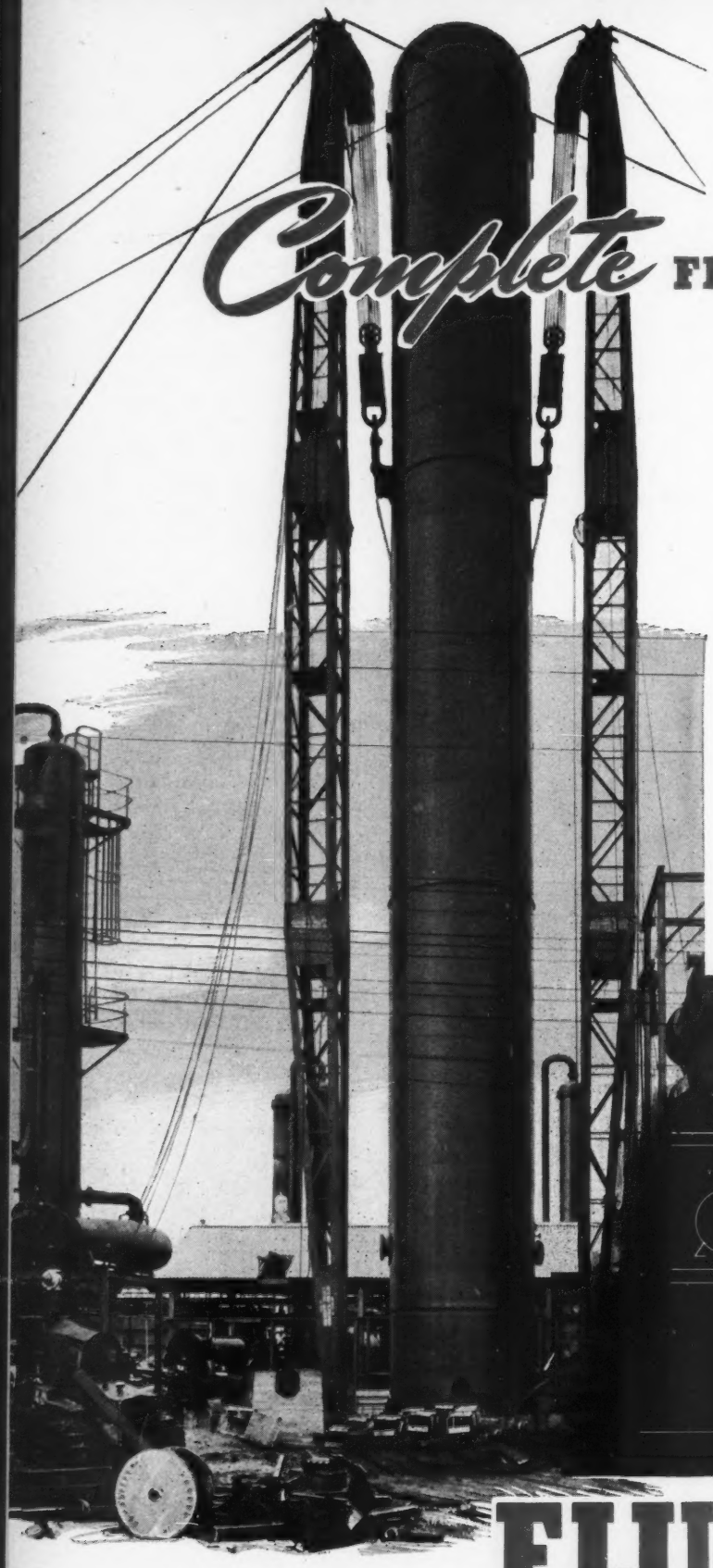
Incidentally, according to the Oil Producers Agency, independent companies (excluding the principal minors) having 17 per cent of the production, are drilling 26 per cent of the wells.

Still, it must be conceded, California's increased production has not kept pace with the growing demand for oil, despite the fact that nearly all wells in the state are producing at their maximum efficient rates. About 130,000 barrels a day are being withdrawn from storage to meet requirements.

This situation was responsible, ostensibly, for the recent hearing of the State Assembly's interim committee in Los Angeles. The committee, presumably, wished to find out how the state might cooperate with the PAW and the industry to further increase crude oil production. But its time was taken up largely by witnesses who wished, for reasons of their own, to get over the idea to the public that the PAW had botched the whole job and that Mr. Ickes should be removed as Petroleum Administrator.

If anything is to be learned from such proceedings it is this: As the

(Continued on Page 6)



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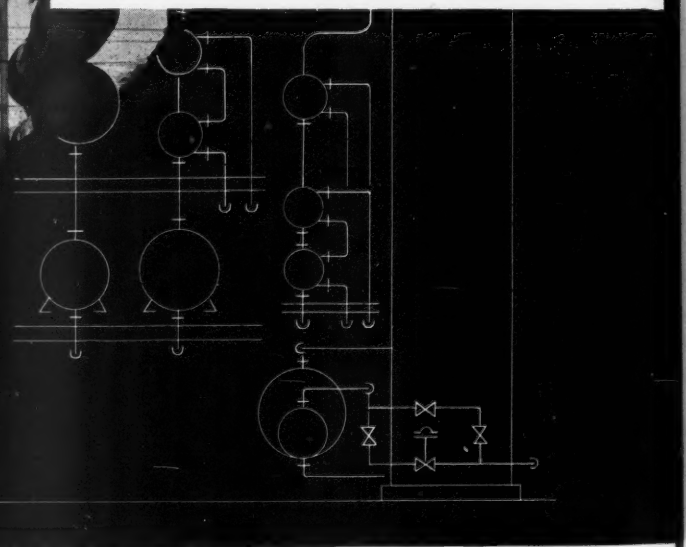

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Reports From Washington

Increased agitation over matters close to the heart of the California oil industry is observed in Washington, as California Oil World goes to press.

With closed sessions on the proposed new Standard Oil Co. of California-Navy Department agreement (permitting Standard to continue production at Elk Hills after turning over its holdings to the Navy) brought to a jarring halt before the House Naval Affairs Committee, only grief may be expected from that very important quarter.

The crude oil price increase is thoroughly snarled, at this point, by the Administration-Congressional row over prices and wages, and the specter of a new attack on the title to California's submerged oil desposits is peeking coyly out from the most unexpected places. We cannot, truly, prophesy a real development for California oil men to give thanks for, on Thanksgiving day.

Since this correspondent will be in California almost by the time this issue hits the street, the matter of reporting things which have not yet happened becomes more perilous than ordinarily. Nobody can predict what the mercurial disposition of certain Congressmen may do to the oil price matter; nobody knows where Economic Stabilization Director Vinson will wind up with his "hold-the-line" struggle; nobody knows what will happen to Standard of Cal. when the current scuffle over whether the Elk Hills oil lands should be condemned by the Government or whether the company should be allowed to continue production under a contract with the Navy Department is ended.

At this writing, about all that can be said on the Elk Hills investigation is that the Justice Department appears about to mess up the whole deal once again. With expert witnesses in the process of being heard, and with Standard about to have its first chance to explain its story to a Congressional committee, the Naval Affairs Committee executive sessions were abruptly halted with an ultimatum from Justice that Assistant Attorney General Norman M. Littell had not had sufficient time in which to study the new agreement. (Re-drafts of the new contract between the Navy Department and Standard have, at all times since its inception, been available to the Justice Department. The final agreement has been in Littell's hands for approximately three weeks.)

When the hearings started, Nov. 9, a current of optimism ran through proponents of the plan to turn over Standard's Elk Hills holdings to the Navy Department under an arrangement through which the oil company would be permitted to produce from the area for the duration of the war or a specified time of a few years. During hearings, early this summer, before the House Public Lands Committee, no real technical witnesses—either for Standard or the Navy—were called and most of the time was taken up by Littell, who charged the original contract was "illegal and invalid" and hinted strongly at another Teapot Dome scandal.

Appearing before the House Naval Affairs Committee—even though the hearings were held in executive session—the parties to the now-abrogated contract felt there was a good chance of telling their story for the first time, in full. The feeling of some committee members who felt that condemnation proceedings was the only answer to the problem was reported "considerably changed" by testimony from some of the Navy witnesses.

It looked—just prior to Littell's refusal to testify until he had had further time in which to study the new contract—as though the House group would call to the stand some company witnesses; numerous technical experts and others who could explain the Standard-Navy position in detail. It also looked as though an early verdict would be rendered, with a printed report of the entire proceedings made available to the public.

All this was changed when Littell failed to appear on the day he was expected. The committee, at the moment, is holding hearings on another matter and no one knows when the subject of Elk Hills will be taken up where it was left off.

This poses the question of the interim agreement—through which Standard is producing approximately 15,000 B/D while awaiting either confirmation of the new contract or the news that the Government will take over the property by condemnation. The interim agreement runs out Dec. 8, and some observers express doubt the matter will be cleared up by that date. Presumably, arrangements will be made for a 30-day extension, pending a late decision.

Here are some of the most telling points in the argument for continued production by Standard Oil from the Elk Hills area:

In the belief of numerous attorneys, condemnation proceedings would result in closing down production while the litigation was in

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progress. With California facing an alarming shortage of petroleum products the 15,000 barrels daily now being produced from the disputed territory will be badly needed.

Contrary to the arguments made by the Justice Department and the belief of many members of Congress, the Navy's purpose no longer is to "lock in the ground" the oil which is being recovered from the Standard leases. Oil from the property now yields 77 per cent refined products, as against only 20 per cent of fuel oil, and much of this goes into the production of vital 100 octane aviation gasoline. Cessation of production would diminish the present annual production of 100 actane by several million gallons.

Under a "business arrangement" between the company and the Navy Department, the taxpayer will come off lightly compared with the cost of taking the lands by condemnation. Unitization of Navy-Standard holdings in the checker-board area of Elk Hills, with the Navy holding control over production but permitting the company to produce enough oil to insure a fair return for giving up the valuable properties, would be the most equitable solution for all concerned—Navy, Standard and the public.

While detail of the new contract have not been made public, it is understood Standard has made further concessions in order to overcome various criticisms of the original agreement voiced by the Justice Department and various other Government agencies.

Regarding the flurry caused in California oil circles over reports that Comptroller General Lindsay Warren's office was digging into the long-dormant question of ownership to California's undersea oil deposits,—a peculiar air of mystery surrounds the entire subject.

The Senate Public Lands Committee—supposed to have been called upon to furnish testimony amassed during several years of hearings on the controversial tidelands oil issue —stated that, although a "detailed letter on the reorganization of Federal Lands" has been received from the General Accounting office, there had been no official correspondence from that agency on the tidelands matter, as far as could be ascertained.

A. B. Thomas, assistant chief of the GAO's Claims Division, said that his office was trying to centralize in the Public Lands Office all activities pertaining to the purchase and recording of lands but that this should not affect the question of title to the tidelands.

After further checking, Thomas found that a resolution submitted last June by Senator Nye—(author of several bills challenging ownership of the submerged oil lands) had been received by the GAO,—but this particular piece of legislation authorized investigation of the Elk Hills contract between Standard and the Navy and did not affect the tideland question.

The only explanation Thomas could offer was that a misunderstanding might have arisen from the fact the office had called for a "Nye bill" (presumably at the time of last summer's Elk Hills investigation) and that this might have brought about the impression that Warren's aides were looking into Nye's tideland proposals . . . In any event, interest of the Accounting office—whose purpose is to keep watch over public expenditures—in tideland legislation which has never been passed by Congress probably would be purely academic.

If the battle to establish sovereignty over the tidelands in the U. S. is to be renewed, the most logical place to look for trouble is the House Public Lands Committee, whose chairman, Representative J. Hardin Peterson of Florida, is known to be interested in the subject. However, since oil has been discovered in Florida, and some geologists are of the opinion that there is an excellent possibility of making further discoveries in the state—perhaps offshore—the Florida member of Congress may be dissuaded before any date is set for hearings.

On the subject of crude oil prices, much clamor for an increase is heard in Congress and many members have expressed displeasure—to put it mildly—with Economic Stabilization Director Vinson for his recent refusal to hike prices. Headed by Representative A. J. Elliott, of Tulare, a petition to discharge the Disney bill from the House Banking and Currency Committee for action, is nearly "over the top" with the 218 signatures required.

A recent Lea Committee Hearing. Photo by Del Ankers.

The Disney bill, stripping the Office of Price Administration of any power in the matter of oil prices and giving such authority to the Petroleum Administration for War, would prevent the establishment of any price ceiling below the general commodity index. It does not, however, recommend any specific price boost.

Many observers believe that a subsidy-hating Congress will pass the Disney bill when it reaches the floor of both House and Senate. President Roosevelt, however, would almost certainly veto the legislation.

Although proponents of the Disney bill appear confident of success, some lawmakers feel that the only manner in which legislation affecting the price of crude can be enacted will be through the old trick of attaching it to a bill which the Administration wants,—as a rider.

It has been suggested that one of the numerous bills advocating an increase could be tacked onto the tax bill, for example . . . In a case of that sort, it could not be knocked out by Presidential veto, unless the tax bill were scrapped with it.

Elliott, incidentally, has changed his attitude on the Elk Hills matter. Condemnation of Standard's holdings would mean a loss to Kern county (Elliott's district) of approximately $1,000,000 a year . . . The California Congressman, although he is not a member of the Naval Affairs Committee, had received permission to appear before the group to argue this point when the hearings were suspended.

Blasts delivered against the PAW before a California assembly committee on petroleum, some days ago, seemingly aroused very little interest in Washington.

Asked to comment on the charges of bungling and inefficiency brought by J. A. Smith of the Independent Consumers Petroleum Association, and Lyman G. Hisey, president of the Alliance Petroleum Corp., one high official in the Government oil agency said:

"The charges are all too preposterous to be worthy of any comment at all".

A telegram from two members of the Independent Oil Producers Agencies of California—A. J. Crites and H. F. Owen—assured the PAW that the Smith and Hisey statements did not "in anyway express the attitude of some California independent producers towards you". Crites and Owens said that they were asking "some of the most important agencies of California" to wire PAW —presumably repudiating the statements.

Increasing petroleum shortages in California and the probability that, after the first of the year, gasoline ration coupons will be cut to two gallons are two unpleasant facts for the California public to brace themselves for.

Although Petroleum Administrator Ickes and Deputy Petroleum Administrator Davies repeatedly have warned that increasing military demands will be felt throughout the country and that the West will have to import gasoline if essential civilian needs are to be met, Westerners are showing the same disregard the East once showed.

"Only when California runs out of oil, will the public believe there is a real shortage," commented one PAW official.

Supplementary Order No. 4 Amended

Removal of restrictions on the reworking of oil wells in California, provided the reworking is done in the same pool in which the well is presently producing, has been announced by Deputy Petroleum Administrator Ralph K. Davies.

Object of the action, which was taken by amending a formal PAW order (Supplementary Order No. 4 to Petroleum Administrative Order No. 11), is to obtain maximum return of oil with the steel available for oil production in California.

Other changes in amendment, which is effective November 12, are:

(1) Standards governing the installation of pumping or other artificial lifting equipment are modified to provide for the adding of tubing and rods in order to lower an oil well pump or tubing string in any pumping well, and to permit the installing of at least one artificial lifting unit on each lease regardless of the size of the lease.

(2) Installation of lease oil shipping pumps is now permitted without obtaining prior approval.

(3) Exhibit A of the Order, specifying the well spacing for the individual pools in the State, is revised to include recently discovered pools.

Editorial

(Continued from Page 1)

civilian supply of gasoline becomes barely sufficient for essential motoring, as it inevitably will, there may be other inquiries, both by headline-hunting politicians and others who may sincerely wonder if everything possible is being done to maintain adequate oil supplies. It behooves the Petroleum Administration, and the oil industry as well, to be prepared for such eventualities by marshalling their facts. It must be made clear, for instance, that more oil cannot be obtained from existing wells without lessening their ultimate recovery—that foolish engineering practices today must be paid for by the public tomorrow; that equities between producers in a common pool should be preserved; and that new wells cannot be more closely spaced without uneconomical use of precious steel, which is also needed badly to produce planes and tanks and guns.

Oil has a two-fold obligation—to the military and to the consuming public, with the military getting first consideration. It must be shown that everything possible is being done to fulfill that obligation.

Refinery Processes for War Products

By
F. D. Parker, Chief Process Engineer,
and
E. G. Ragatz, Process Engineer
Bechtel-McCone-Parsons Corporation

Introduction

The petroleum refining industry is doing an outstanding job of producing vitally needed products for this nation's war effort. Natural gasoline manufacturers and refiners of crude oil have pooled their efforts to make the most efficient utilization of every barrel of raw material. It is the purpose of this paper to present a review of the roles that refinery processes are playing in the production of war products, with special emphasis on one of the most vitally needed commodities — 100 octane aviation gasoline.

This paper must, of necessity, be brief to meet the time requirements for presentation, and be general in nature so as to cover the refinery processes of major importance without revealing material which is classified as restricted by the U. S. Patent Office Secrecy Orders.

At the present time natural gasoline plus L.P.G. is being produced in California at the rate of some 46,000 barrels per day, refining crude at the rate of 665,000 barrels per day, and heavy crude at the rate of 115,000 barrels per day. Natural gasoline is normally produced with an end point of 300-325°F. Refining crudes contain materials boiling within the natural gasoline range to the extent of 5% to 25%, depending on the type of crude. Assuming an average content of 12% of this material in the refinery crude, we see that some 80,000 barrels per day, or over 60% of the total California production of straight run fractions falling within the natural gasoline boiling range, are produced at the refinery crude stills. Additional large volumes of these and similar fractions are also produced by cracking. Dr. Boultbee, in a preceding paper, has discussed the general processing of such fractions from the natural gasoline viewpoint. Our paper will largely focus on the processing of these and higher boiling fractions from the crude viewpoint.

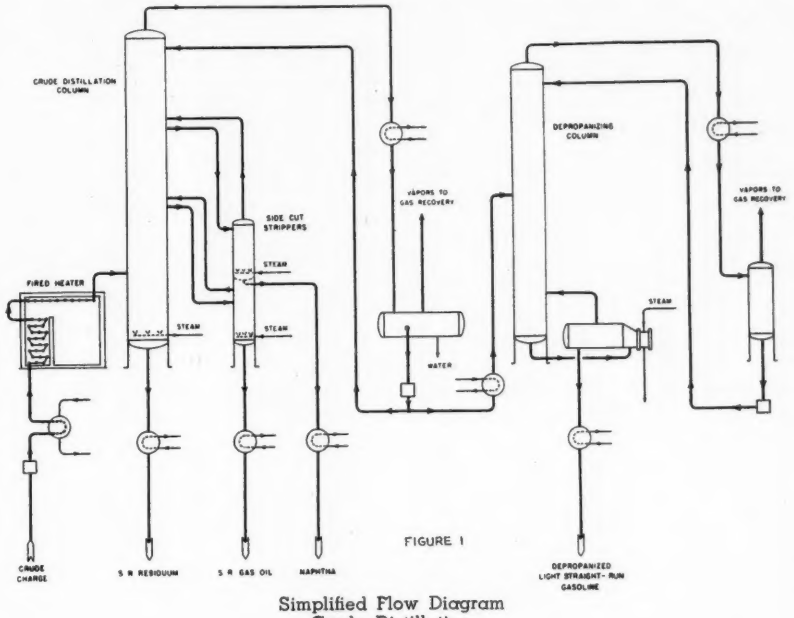


FIGURE 1

Simplified Flow Diagram
Crude Distillation.

Basis For Process Discussion

California war-time refining operations have been markedly influenced by aviation gasoline demand. Since aviation gasoline production is closely allied with natural gasoline operations, our process review will focus primarily on its production. To facilitate the presentation, we will follow the handling of 10,000 barrels of a selected 31° API California crude through three stages of processing, extending from conventional pre-war operations to latest catalytic cracking operations for high yield production of aviation gasoline.

Table 1 shows a straight run distillation breakup of the selected crude into propane and lighter fractions, light straight run gasoline, heavy straight run naphtha, gas oil, and residuum. Typical percentage yields and characteristics of the distillate fractions as they influence aviation gasoline production are given.

TABLE 1
Typical Breakup of a Selected 31° A.P.I. California Crude For Aviation Gasoline Production

Fraction	Reid V.P. Lbs./Sq.In.	Octane CFR-M Clear	Vol. % Basis "O" Loss
C_4 and Lighter	..	..	0.35
Iso-Butane	77	99	0.20
Normal Butane	52	92	0.70
Iso-Pentane	21	90	0.60
Normal Pentane	15.5	61	0.75
C_5—250° Light S. R. Gasoline	5.5	72	5.40
225—450° Heavy S. R. Naphtha	1.5	55	24.00
Total Gasoline and Naphtha Fractions			31.65
450°—700° Gas Oil—41 SSU @ 100°F.			32.0
700° Initial Resid.—100 SSF @ 210°F.			36.0

Conventional Pre-War Processing of Crude Oil Fractions

In the conventional pre-war processing of crude oil for primary products, (i.e. motor gasoline, stove oil, distillate fuels, and residual fuels) with only a small amount of aviation gasoline production, the following operations were adequate to meet product yield and quality requirements:

Crude fractionation
Thermal reforming
Thermal gas oil cracking
Thermal viscosity breaking

A brief review of these older processes appears in order, since they still have a definite place in wartime operations.

A simplified flow diagram of a crude oil distillation unit is shown

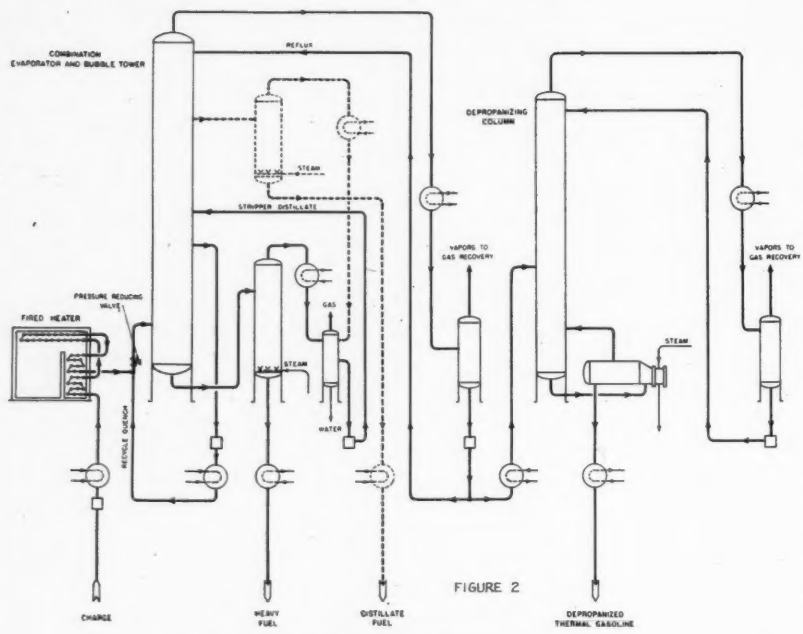


FIGURE 2

Simplified Flow Diagram
"Once Through" Thermal Reforming or Cracking.

in Figure 1. In this unit, crude oil is processed and fractionated in conventional distillation equipment to produce light straight run gasoline, heavy naphtha, gas oil, and heavy residuum cuts of the character outlined in Table 1. The light straight run gasoline would be stabilized in a conventional unit as illustrated, and then used for either motor or aviation gasoline blending.

Figure 2 presents a simplified flow diagram of a typical once-through thermal reforming or cracking unit. In this operation materials such as straight run naphtha are subjected to cracking temperatures and pressures to produce higher octane cracked gasoline, gas, tar and coke. While the flow of materials through the unit is evident from the flow sheet, it may be noted that the feed charge is introduced directly into the coils of the heater, all cracking is effected in the heater coils, the high pressure carried on the heater coils is reduced ahead of the combination evaporator and bubble tower, and a recycle stream of gas oil is used to quench the products leaving the fired heater for the purpose of controlling coke accumulation at the pressure reducing valve and in the transfer line to the evaporator.

A simplified flow diagram of a two-coil thermal cracking and vis-breaking unit is shown in Figure 3. In this operation, a combined stream of gas oil and residuum from the crude distillation unit is introduced into a combination evaporator and bubble tower for separation into heavy and light cracking coil charge streams. These streams are then treated in separate fired heaters under their respective optimum controls. The cracked streams leaving the two fired heaters are combined into a single stream for introduction into the base of the evaporator. The charge stream of the light cracking coil contains both virgin and cycle gas oil. The quantity of gas oil recycled to this coil can be varied to give greater or smaller overall thermal cracked gasoline yields—thus providing flexibility for the process. As with the simple, once-through operation, recycle gas oil is used for quenching the high temperature streams leaving the cracking coils.

As an alternate operation, the gas oil and residuum streams would be separated at the crude distillation unit and cracked separately. In such a case, the flow sheets for the cracking and vis-breaking units would be roughly similar to that presented for the thermal cracker of Figure 2.

Figure 4 presents a simplified block and line flow diagram showing charge and product quantities for a typical pre-war refinery operation utilizing crude distillation, thermal reforming, thermal gas oil cracking, and residual viscosity breaking for the production of motor gasoline fractions, distillate and residual fuel fractions, and a relatively small amount of aviation gasoline. Basis for the quantities presented is a 10,000 barrel throughput of the selected 31° API California crude of the composition shown in Table 1.

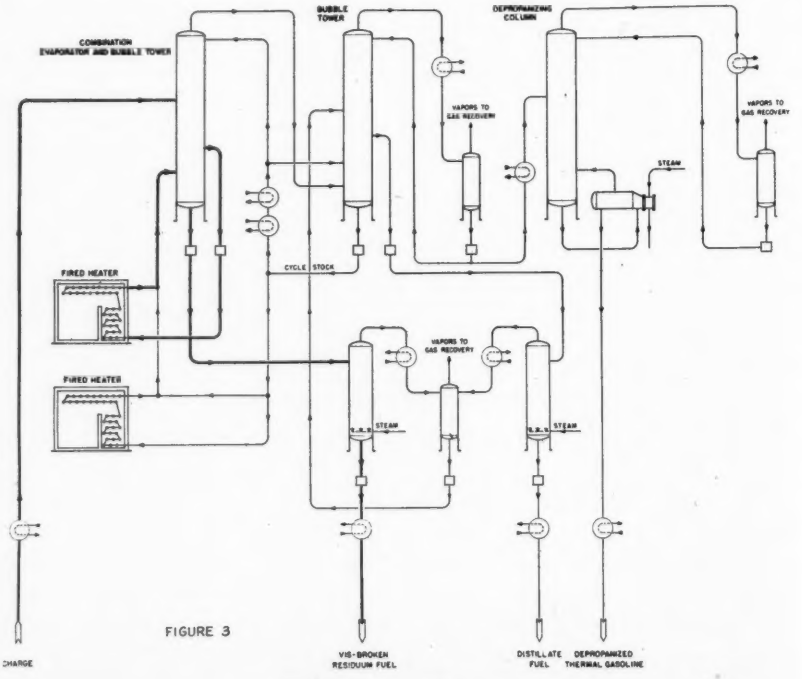


FIGURE 3

Simplified Flow Diagram
Two-Coil Recycle Thermal Cracking and Vis-Breaking.

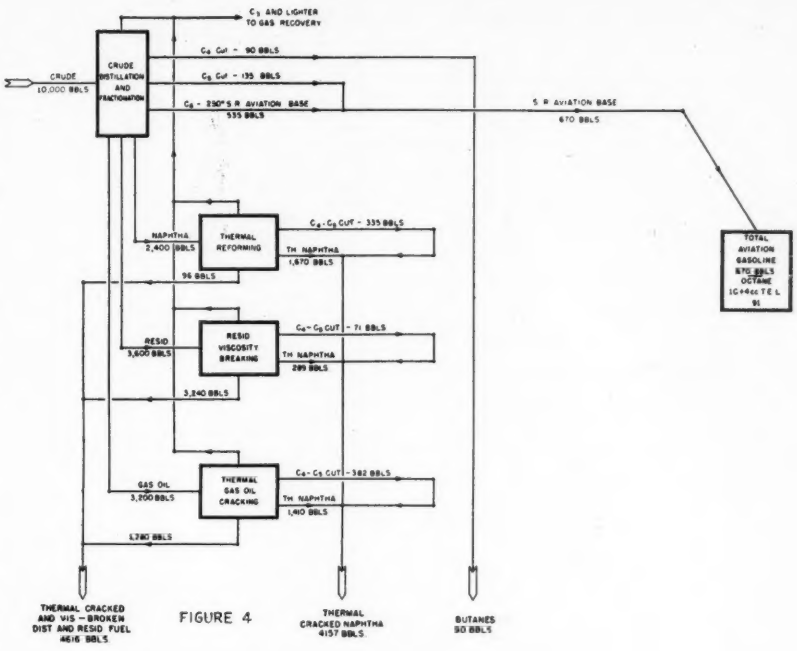
It will be noted that this operation produces only some 6.7% of 91 octane aviation gasoline, even though all usable straight run material is diverted to aviation gasoline production. All thermal butanes and pentanes, as well as the heavier thermal cracked gasoline fractions, are used to impart desired vapor pressure and knock rating characteristics to motor gasoline.

In connection with the indicated yields and product quantities of this flow diagram, as well as others to follow, it would be understood that all secondary production quantities and losses have been ignored in order to simplify the overall process comparison.

War-Time Processing of Crude Oil Fractions with Thermal Cracking.

As noted above, the conventional pre-war refinery equipped for early peace-time operations was provided with crude fractionating and thermal cracking facilities only. As the demand developed for larger quantities of aviation gasoline of higher quality than could be produced from straight run fractions alone, installation of modernized refining equipment was stimulated. The most important items of this modern equipment are alkylation, isomerization, and catalytic cracking units.

Figure 5 presents a simplified flow diagram of a sulfuric acid alkylation unit. In such a unit, propylenes, butylenes, and amylenes are combined with isobutane in the presence of a liquid catalyst (sulfuric or hydrofluoric acid) to produce a high quality aviation gasoline blending agent of relatively low vapor pressure. Feed stock for such units consists of a mixture of olefins and isobutane with some normal paraffins. Isobutane is recycled through the unit along with the incoming feed stock for the purpose of maintaining high ratios of isobutane to olefins in the reaction zone so that polymerization of the olefin portion of the feed may be kept to a minimum. The reaction takes place in the liquid phase. A large emulsion recycle stream is circulated through a chiller in series with the alkylation reactor for control of reactor temperature. Extensive fractionating equipment is employed in connection with the alkylation plant to effect separation of propane, isobutane, normal butane, and pentanes from the effluent stream, and to segregate the alkylate production into aviation alkylate and heavy alkylate bottoms. Alkylate yields are of the order of 1.5-1.7 times the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CRUDE 10,000 BBLS
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C4 Cut - 90 BBLS
C5 Cut - 135 BBLS
C6 - 250° S R AVIATION BASE 535 BBLS
S R AVIATION BASE 670 BBLS
NAPHTHA 2,400 BBLS
THERMAL REFORMING
C4 - C9 CUT - 335 BBLS
TH NAPHTHA 1,670 BBLS
96 BBLS
RESID 3,600 BBLS
RESID VISCOSITY BREAKING
C4 - C9 CUT - 71 BBLS
TH NAPHTHA 299 BBLS
3,240 BBLS
GAS OIL 3,200 BBLS
THERMAL GAS OIL CRACKING
C4 - C9 CUT - 382 BBLS
TH NAPHTHA 1,410 BBLS
1,780 BBLS
TOTAL AVIATION GASOLINE 670 BBLS OCTANE 1.0 + 4 cc T E L 91
THERMAL CRACKED AND VIS - BROKEN DIST AND RESID FUEL 4616 BBLS
THERMAL CRACKED NAPHTHA 4157 BBLS
BUTANES 90 BBLS

FIGURE 4

Simplified Flow Diagram
Production of Aviation Gasoline from 10,000 Bbls. Selected 31° A.P.I. California Crude Termal Cracking Only.

olefin feed, with isobutane requirements amounting to 0.95-1.25 times the olefin feed.

Figure 6 presents a simplified flow diagram of an isomerization unit. As the demand for volume production of aviation gasoline increased, it was often found that the supply of olefins from thermal cracking units exceeded the supply of isobutane available for alkylation plant feed. The isomerization process satisfies this deficiency by the conversion of normal butane to isobutane.

Butane isomerization processes operate in either the vapor or liquid phase, according to the requirements

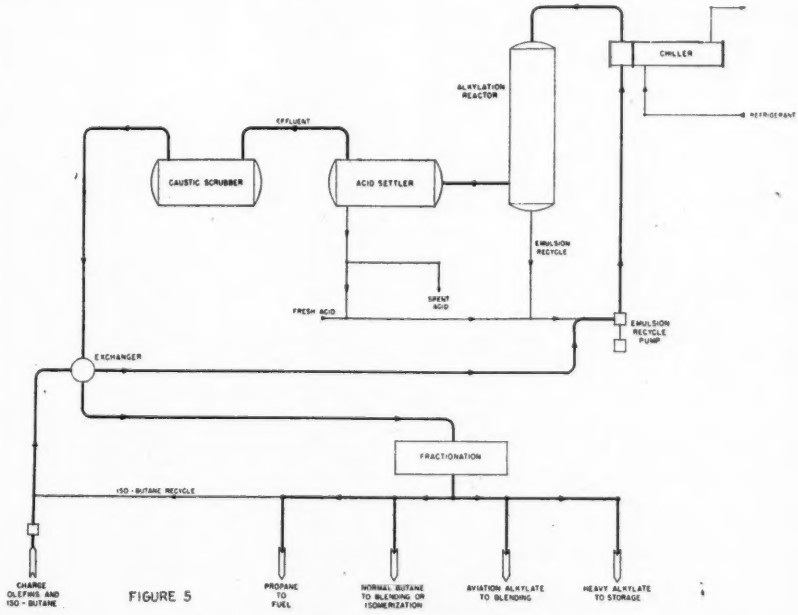


FIGURE 5

Simplified Flow Diagram
Sulphuric Acid Alkylation Process.

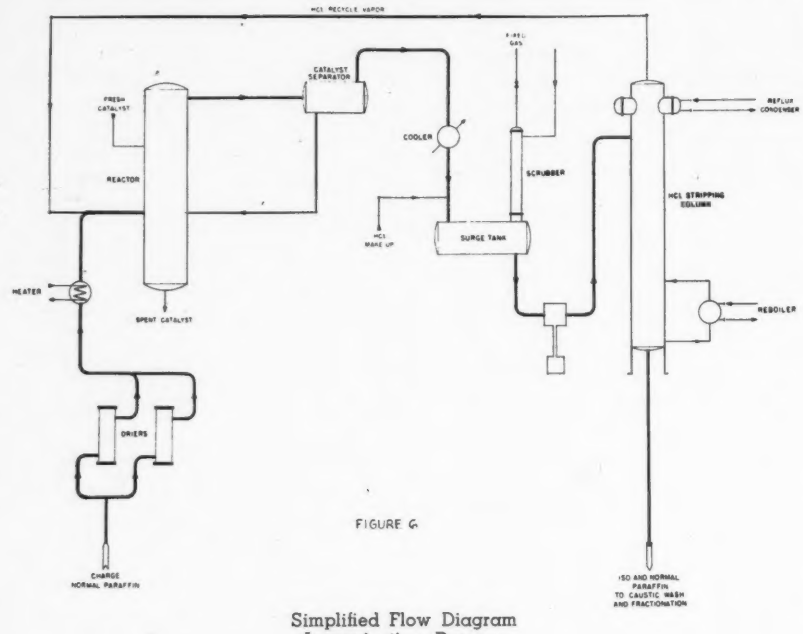


FIGURE 6

Simplified Flow Diagram
Isomerization Process.

of the process in question. Aluminum chloride is the basic catalyst used in all cases. The aluminum chloride may be sublimed and deposited on a solid carrier, or handled as a liquid by forming an aluminum chloride complex or mixture with other materials. In all cases, hydrogen chloride is used as an activator for the catalytic action, requiring facilities for thoroughly drying the incoming feed stream in order to avoid hydrochloric acid corrosion of the equipment. Isobutane yields of the order of 40-50% per pass are obtained, with total conversion yields amounting to over 95% of the net butane charge.

The isomerization process can also be adapted to pentane and hexane isomerization for the direct production of aviation gasoline blending agents.

Figure 7 presents a block and line flow diagram of the original pre-war refinery operation of Figure 4, modified to include butane and pentane alkylation, butane isomerization, and pentane fractionating operations. Addition of alkylate and removal of normal pentane from the aviation gasoline blend makes it possible to readily produce 100 octane materials; olefins, isobutane, and isopentane from the thermal cracking units formerly used for motor gasoline blending are now diverted to aviation gasoline production; and the total yield of aviation gasoline is substantially increased—amounting to some 12.7% of 100 octane gasoline as compared with the original 6.7% production of 91 octane material. In order to achieve this yield, however, the plant-produced butane feed stock for butane isomerization had to be augmented by some 134 barrels from an outside source.

Though the thermally cracked gasoline contains a large amount of material boiling within the aviation gasoline range, none of this material can be included in the aviation gasoline blend due to its high olefin content. As a consequence, increasing the aviation gasoline production beyond that characterized by the operations of Figure 7 requires the use of a cracking operation which will produce high yields of aromatics and isoparaffins in place of the high olefin yields of the thermal cracking units. This need is met by catalytic cracking.

Catalytic Cracking Processes

In contrast to the relatively simple process flows of the older thermal cracking units, the process requirements of catalytic cracking cycles appear rather complex. This is due to the fact that coke resulting from the cracking reaction deposits on the catalyst, and must be removed by burning in order to maintain catalyst activity. Methods of heat control, heat recovery, and catalyst handling employed in the regeneration of the catalyst constitute the distinguishing mechanical differences in today's commercial catalytic cracking process.

While differing in methods employed for catalyst handling and regeneration, and in the specific catalyst used, the three commercial cata-

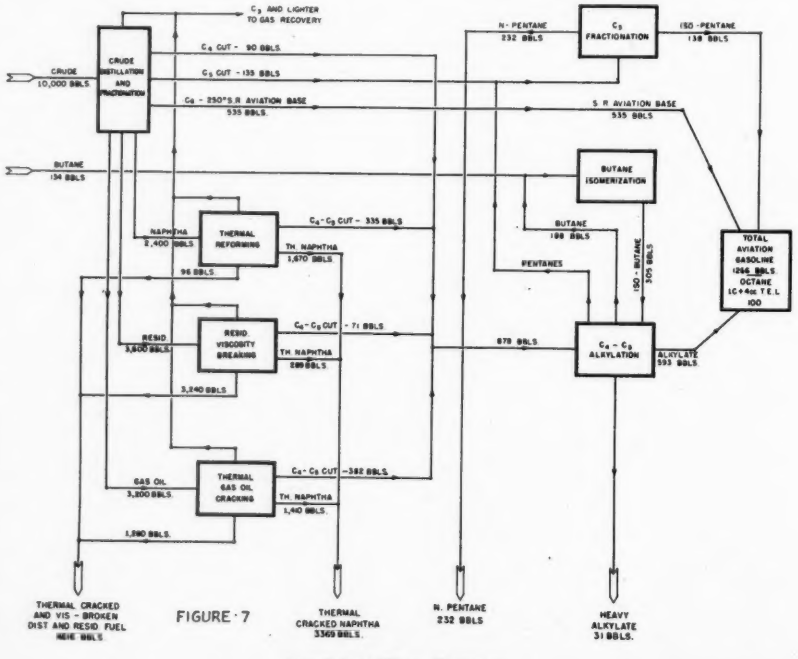

C3 AND LIGHTER TO GAS RECOVERY
CRUDE DISTILLATION AND FRACTIONATION
CRUDE 10,000 BBLS
C4 CUT - 90 BBLS.
C5 CUT - 135 BBLS
C6 - 250°S.R AVIATION BASE 535 BBLS.
BUTANE 134 BBLS
NAPHTHA 2,400 BBLS
THERMAL REFORMING
C4 - C9 CUT - 335 BBLS
TH. NAPHTHA 1,670 BBLS
96 BBLS.
RESID 3,600 BBLS.
RESID VISCOSITY BREAKING
C6 - C9 CUT - 71 BBLS
TH. NAPHTHA 289 BBLS
3,240 BBLS
GAS OIL 3,200 BBLS.
THERMAL GAS OIL CRACKING
C6 - C9 CUT - 382 BBLS.
TH. NAPHTHA 1,440 BBLS.
1,260 BBLS.
THERMAL CRACKED AND VIS - BROKEN DIST AND RESID FUEL 1696 BBLS
THERMAL CRACKED NAPHTHA 3369 BBLS.
N- PENTANE 232 BBLS
C5 FRACTIONATION
ISO - PENTANE 138 BBLS
S.R AVIATION BASE 535 BBLS
BUTANE ISOMERIZATION
BUTANE 188 BBLS
PENTANES
ISO - BUTANE 305 BBLS
TOTAL AVIATION GASOLINE 1296 BBLS OCTANE 1C+4cc T.E.L 100
878 BBLS
C4 - C9 ALKYLATION
ALKYLATE 593 BBLS
N. PENTANE 232 BBLS
HEAVY ALKYLATE 31 BBLS.

FIGURE 7

Simplified Flow Diagram
Production of Aviation Gasoline from 10,000 Bbls. Selected 31° A.P.I. California Crude
Thermal Cracking + Alkylation + Butane Isomerization.

lytic cracking processes in use today; namely, Houdry, Fluid, and Thermofor Catalytic Cracking (TCC) have the following process features in common:

1. All use solid catalysts of the contact or absorptive type.
2. The catalysts are chiefly natural and chemically treated clays, or synthetic materials of the same general composition.
3. The cracking reaction is effected wholly in the vapor phase in the presenec of the catalyst at low pressures of the order of 10 to 50 lbs. sq. in. ga.
4. Cracking temperatures of the order of 800-1000°F., and maximum regeneration temperatures of the order of 1100-1200°F., are employed.
5. A circulating cooling system is used to control the temperature of the catalyst during regeneration, and to remove and recover waste heat.
6. The catalyst slowly loses its efficiency in operation and must be periodically or continuously replaced with fresh material.
7. The depth and character of cracking is primarily governed by the specific type of catalyst employed, degree of catalyst activity, catalyst to oil ratio, time of contact, and cracking temperature.

Catalytic processes employing solid catalysts may be broadly divided into two classifications according to the method employed for handling the catalyst:

1. Static Bed Processes, in which the catalyst remains static in the reactor case during both cracking and regeneration, and in which the case is alternately shifted from one operation to the other by appropriate valving.
2. Moving Bed Processes, in which the catalyst continually circulates through separate cracking and regeneration zones with continuous flows of oil vapors and regenerating air being maintained through the respective reactor and regenerating sections.

The Houdry Process belongs to the first class, and the Fluid and TCC Processes to the second class.

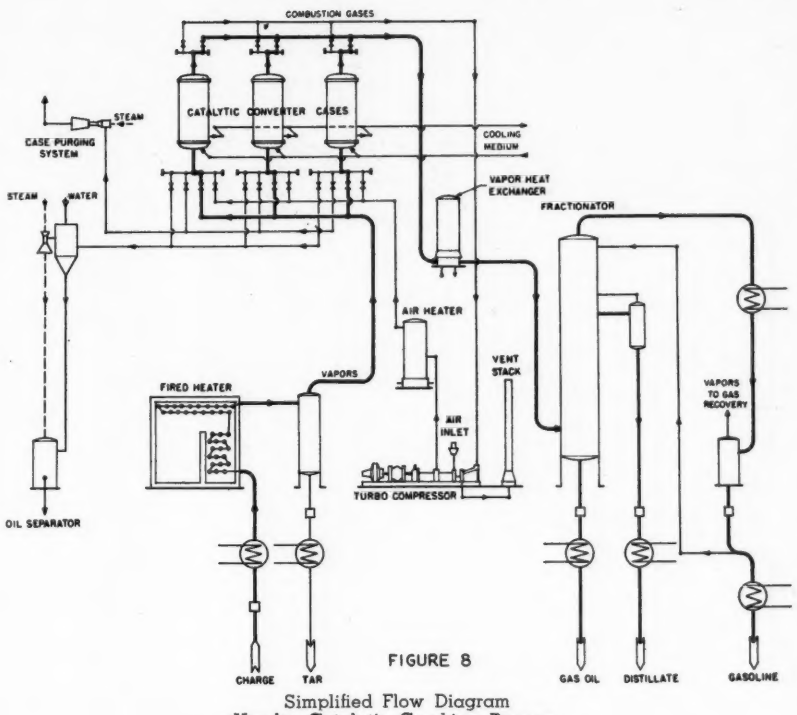


FIGURE 8

Simplified Flow Diagram
Houdry Catalytic Cracking Process.

Houdry Process

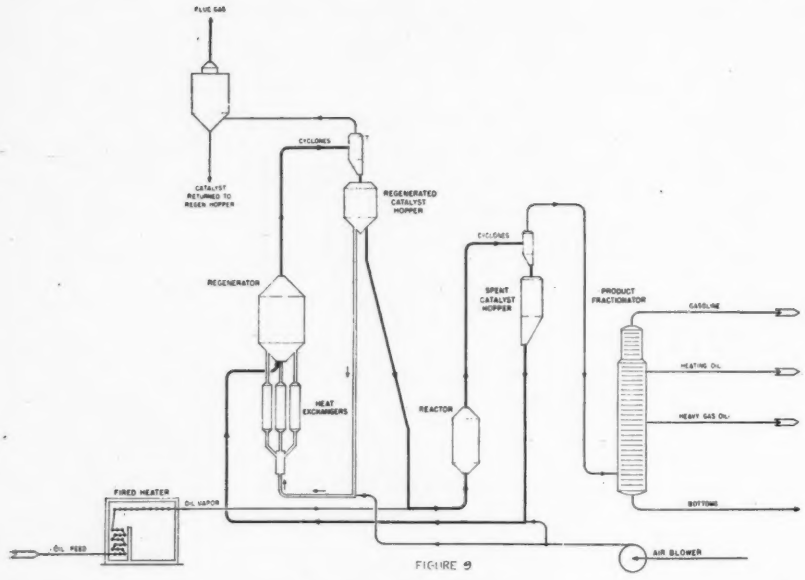
Figure 8 presents a simplified flow diagram of the Houdry Process. In this process, a number of static bed catalyst cases are manifolded together and so operated that one or more cases are always on stream for cracking service while others are being purged and regenerated. The essential elements of the process consist of:

1. Conventional fired heaters and separators for supplying a vaporized feed to the catalyst cases.
2. A plurality of catalyst cases—usually three or more units.
3. An automatically timed valving system for synchronously shifting case services.
4. Purging facilities for removing oil vapors and combustion gases from the cases.
5. A heated air supply for catalyst regeneration.
6. A molten salt circulating system for control of reaction temperatures and removal and recovery of excess heat.
7. Turbo generators for waste heat recovery.
8. Conventional fractionating equipment for separating the cracked materials into appropriate cuts.

The catalyst employed in the Houdry Process is usually in the form of pellets approximating 1/6" in diameter and length. Finned tubes are distributed through the catalyst bed to accommodate the circulating salt system. This system serves the threefold purpose of removing excess heat during the regenerating period, adding heat during the on-stream cracking period, and recovering waste heat through interchange with feed stock and/or generation of stream. Each case in turn is held on stream for a definite period of time set by the amount of coke which can be allowed to accumulate on the catalyst without too adversely affecting catalyst efficiency. During this period the other cases are purged and regenerated. Cases are synchronously shifted from service to service by an automatically timed valving system, thus assuring continuity of oil vapor flow. Regeneration air is supplied at a pressure of 45-50 lb. gage. Heat energy is recovered from the resultant high temperature combustion gases by using them to drive a turbo generator.

Fluid Process

Figure 9 presents a simplified flow diagram of the Fluid catalytic cracking process. In contrast to the multiple service cases of the Houdry process, this system employs separate reactor and regenerator units.



Simplified Flow Diagram
Fluid Catalytic Cracking Process.

Catalyst in finely powdered form is circulated continuously through first the reactor and then the regenerator zones by vapor and air stream action. A continueous flow of oil vapors is maintained through the reactor zone, and a continuous flow of hot air for catalyst regeneration through the regeneration zone. Essential elements of the process consist of:

1. Conventional fired heaters and separators for supplying vaporized feed to the reactor.
2. Separate reactor and regenerator vessels.
3. Hoppers and standpipes for feeding circulating catalyst into the oil-vapor and hot-air streams.
4. Cyclone separators for removing catalyst from the oil-vapor and combustion gas streams leaving the reactor and regenerator zones, and Cottrel precipitators for removing catalyst fins from the exit flue gases.
5. An air supply for catalyst regeneration.
6. A secondary air-actuated catalyst recirculating system for removing and recovering excess heat from the regenerating zone.
7. Conventional fractionating equipment for separating the cracked materials into desired cuts.

The catalyst used in the Fluid process is a fine powder, ranging in size from 300 mesh down to a few microns, and is of such a character that it can be handled similarly to a freely flowing fluid. The catalyst is introduced into the vapor and oil streams by the differential head built up by compacted catalyst in hopper standpipes, and then circulated through the heat exchangers, treaters, regenerators, dust separators, etc., by the kinetic energy of the flowing air and oil vapor streams. Cyclone separators remove the catalyst from the exit vapor streams and return it to the feed hoppers for recirculation through the system. Temperature control at the regenerator is obtained by recirculation of regenerated catalyst through interchangers operated in series with the regenerator. Excess heat is removed by interchange with incoming feed stock and/or steam generation. Density of the catalyst-vapor system in the reactor can be varied to obtain desired catalyst to oil flow ratio. Rates of catalyst circulation through the reactor are set to meet process requirements. An extremely uniform temperature is maintained throughout the treater vessel.

T. C. C. Process

Figure 10 presents a simplified flow diagram of the TCC process. In contrast to the Fluid process, the TCC process uses a catalyst in the form of pellets or beads which are moved through separate reactor and regenerator units by gravity. Continuous flows of oil vapors and regeneration air are maintained through the reactor and regenerator units. Essential elements of the process consist of:

1. Conventional fired heaters and separators for supplying vaporized feed to the reactor case.
2. Separate reactor and regenerator units.
3. An elevated catalyst hopper, and a pair of catalyst elevators for maintaining flow of catalyst through the system.
4. Dust separators for removing catalyst fines from the exit combustion gas stream.
5. An air supply for catalyst regeneration.
6. A high pressure water circulation and steam generating system for control of catalyst regeneration temperature and recovery of waste heat.
7. A conventional fractionating system for separating the cracked products into desired cuts.

The TCC catalyst may be in the form of chemically treated natural clay particles varying in size from 4 to 60 mesh, synthetic pellets, or the new synthetic bead catalyst which is approximately ⅛" in diameter. Catalyst is introduced into the reactor by gravity head developed in a hopper and standpipe located above the reactor. Subsequent flow is downward by gravity through the reactor in counter-current flow to the oil vapor stream, up by elevator to the top of the regenerating kiln, down by gravity through the regenerator, and up by elevator to the catalyst hopper. Cyclone separators remove catalyst fines from the exit combustion gases. Temperature control in the kiln is obtained by direct generation of 400-500 lbs. steam in boiler tubes distributed through the kiln. Regeneration air is supplied at a number of points in the kiln, with resultant combustion gases being removed from multiple takeoffs adjacent the air inlets. Rates of catalyst circulation are largely set by process requirements.

The new synthetic bead catalyst used with the TCC process is extremely rugged. This ruggedness, combined with exceptional catalytic

performance in the production of aviation gasolines, makes it extremely attractive for the mechanical circulation system of the TCC operation.

Catalytic Cracking for Aviation Gasoline Production

While details of operation and control vary considerably between the three catalytic cracking processes now in commercial operation, the following important generalizations can be made regarding the utilization of catalytic cracking and treating for the production of high quality aviation gasoline components.

1. Highest quality aviation gasolines are produced from naphthenic feed stocks, and lowest quality from paraffinic feed stocks.
2. Increasing the temperature and severity of cracking increases the yields of olefins and isobutane in the lower aviation gasoline boiling range, and the yields of aromatics in the higher boiling ranges.
3. High aviation gasoline qualities and yields are obtained by secondpass treatment of a butane or pentane-free first-pass high end point gasoline cut—with the treating conditions being more severe for the second pass treating operation than the first-pass cracking operations.
4. The quality increase achieved by second-pass treatment is obtained through elimination of olefins from the lower boiling fractions, and production of additional aromatics in the upper boiling fractions.
5. In addition to producing high quality aviation base stock, two-pass catalytic cracking simultaneously yields substantial quantities of isobutane and olefins for alkylation. High yields of isopentane are also obtained—with this production often being larger than can be utilized in the 7-lb. Reid catalytic aviation gasoline blend.
6. The heavier the charging stock from a given crude source, the higher the olefin yield.
7. Within limits, relative productions of isoparaffins and olefins can be varied by choice of catalyst used, and depths and severity of cracking employed.

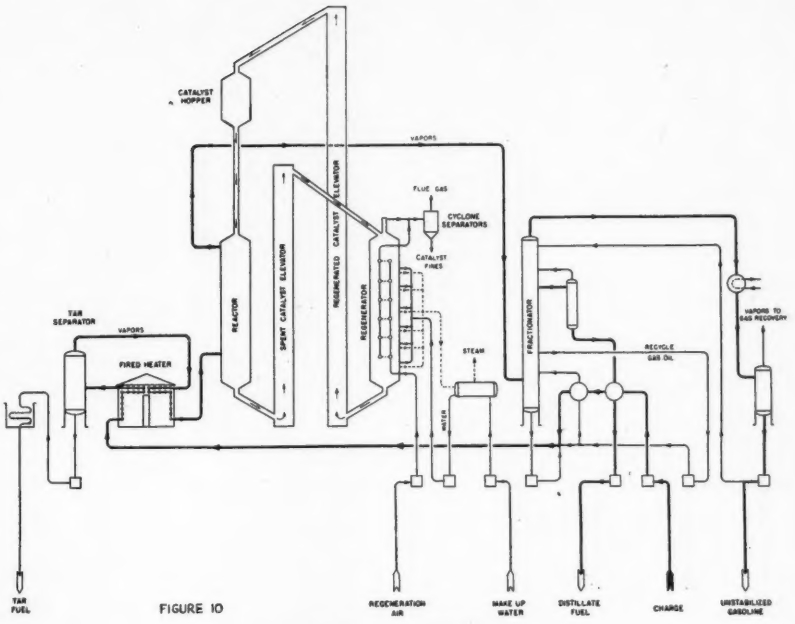


FIGURE 10

Simplified Flow Diagram
Thermofor Catalytic Cracking Process.

8. The 7# Reid catalytic aviation gasoline will in general fall within the following quality ranges:

Octane Rating	
ASTM Clear	77 — 82
AFD — 1C + 4 cc TEL	92 — 97
Acid Heat, °F.	10 — 25
Aromatic Content, Volume Pct.	20 — 30

War-Time Processing of Crude Oil Fractions With Catalytic Cracking

Figure 11 presents a block and line flow diagram in which two-pass catalytic cracking of gas oil replaces the recycle thermal gas oil cracking of Figure 7. With this substitution the production of 100 octane aviation gasoline is again doubled, and a surplus of 436 bar-

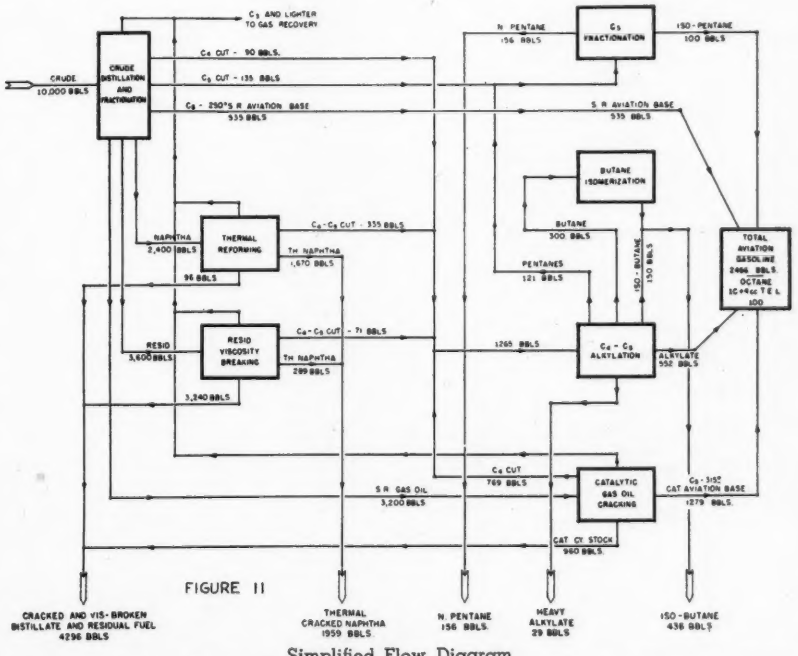

C3 AND LIGHTER TO GAS RECOVERY
CRUDE 10,000 BBLS
CRUDE DISTILLATION AND FRACTIONATION
C4 CUT - 90 BBLS.
C5 CUT - 135 BBLS
C6 - 250°S R AVIATION BASE 535 BBLS
N. PENTANE 156 BBLS
C5 FRACTIONATION
ISO-PENTANE 100 BBLS.
S R AVIATION BASE 535 BBLS
BUTANE ISOMERIZATION
BUTANE 300 BBLS
PENTANES 121 BBLS
ISO-BUTANE 150 BBLS
TOTAL AVIATION GASOLINE 2486 BBLS OCTANE 1C+4cc TEL 100
NAPHTHA 2,400 BBLS
THERMAL REFORMING
96 BBLS
TH NAPHTHA 1,670 BBLS
C6-C8 CUT - 355 BBLS
RESID 3,600 BBLS
RESID VISCOSITY BREAKING
3,240 BBLS
C6-C8 CUT - 71 BBLS
TH NAPHTHA 299 BBLS
1265 BBLS
C4 - C5 ALKYLATION
ALKYLATE 352 BBLS
C4 CUT 769 BBLS
S R GAS OIL 3,200 BBLS
CATALYTIC GAS OIL CRACKING
C6-350 CAT AVIATION BASE 1279 BBLS.
CAT CY STOCK 960 BBLS.
CRACKED AND VIS-BROKEN DISTILLATE AND RESIDUAL FUEL 4296 BBLS
THERMAL CRACKED NAPHTHA 1959 BBLS
N. PENTANE 156 BBLS
HEAVY ALKYLATE 29 BBLS
ISO-BUTANE 436 BBLS

FIGURE 11

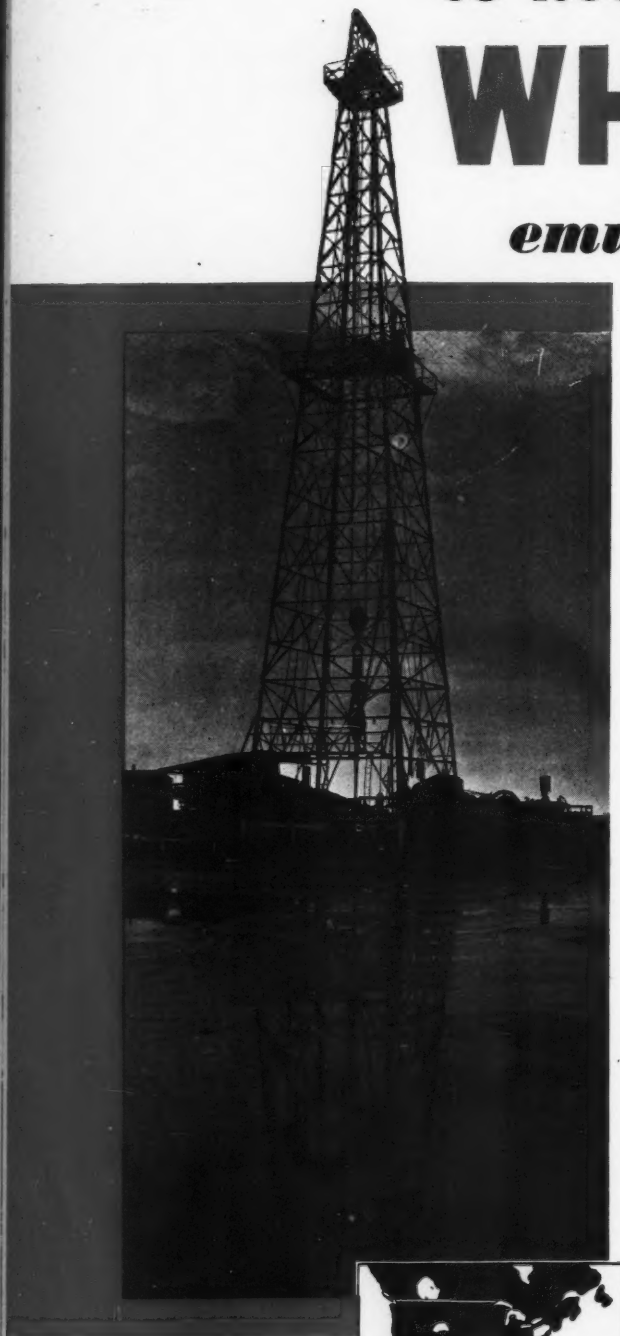
Simplified Flow Diagram
Production of Aviation Gasoline from 10,000 Bbls. Selected 31° A.P.I. California Crude
Thermal Cracking + Alkylation + Butane Isomerization + Catalytic Cracking.

HOW

to keep treating costs down

WHEN

emulsion troubles develop



USE TRET-O-LITE

Tret-O-lite dehydrating compounds have been treating emulsified crudes in domestic and foreign oil fields for many years. When you rely on Tret-O-lite for dehydration, as most producers do, you are assured of reliable compounds and dependable service. For any emulsion problem, get in touch with your Tret-O-lite representative.

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Oil is Ammunition–Treat it Right

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DEHYDRATING DESALTING

TABLE 2

Production of Aviation Gasoline
From 10,000 Bbls. Selected 31° A.P.I. California Crude

	QUALITY		PRODUCTION—BBLS.		
	Reid V.P. Lbs./in²	Octane 1C+ 4cc—T.E.L.	"A" Thermal Cracking	"B" "A"+Alk. +C_4 Isom.	"C" "B"+Cat. Cracking
Aviation Gasoline Components					
C_5 Free Virgin Base Stock	3.5	90.0	535	535	535
C_5 Free Catalytic Cracked Base Stock	2.5	96.0	...	...	895
C_4 Alkylate	4.0	i+0.8	...	347	400
C_5 Alkylate	2.5	i+0.5	...	246	152
Iso-Pentane	20.6	i+1.5	60	138	436
Pentenes	15.5	74	...	...	16
Normal Pentane	15.5	87	75	...	32
Case "A"—Blended to 91 Octane	6.4	91	670	...	...
Case "B"—Blended to 100 Octane	5.2	100	...	1266	...
Case "C"—Blended to 100 Octane	6.1	100	...	...	2466
Normal Butane (Deficiency)				(134)	
Iso-Butane Surplus					436
Total "Net" Aviation Component Yield			670	1132	2902
Remaining C_5—410° Gasoline Components					
Iso-Butane			83	...	...
Butene			215	...	...
Normal Butane			188	...	...
Iso-Pentane			78	...	...
Pentenes			157	...	...
Normal Pentane			157	232	156
C_5—410° Thermal Cracked Naphtha			3369	3369	1959
Heavy Alkylate			...	31	29
Total Remaining C_5—410° Components			4247	3632	2144
Fuel Oil Components—total			4616	4616	4296
Total "Net" C_5 Free Liquid Components			9533	9380	9342

TABLE 3

Motor Gasoline Production
Cracking of Light and Heavy Gas Oils by two different Catalytic Processes

Feeds		
Gravity—°API	22.3	33.6
Aniline Point, °F.	171	135
ASTM 50% distn. —°F.	825	485
Sulfur — Wt. %	2.49	0.46
Yields		
Motor gasoline—Vol. %	46.0	46.4
Cracked gas oil—Vol. %	51.2	38.8
Excess Butanes—Vol. %	2.0	11.3
Dry Gas—Wt. %	5.6	7.0
Coke Prod.—Wt. %	3.4	4.0
Motor Gasoline Properties		
Gravity—°API	58.2	54.2
Reid V. P.—Lbs./sq. in.	10.0	9.5
Sulfur—Wt. %	0.246	0.08
Aniline No. — °F.	82	63
Acid Heat	186	32
Octane No.		
CFR-M Clear	77.9	82.6
CFR-M +1.5cc T. E. L.	81.2	87.0
CFR-R Clear	91.3	92.7
CFR-R + 1.5cc T. E. L.	95.3	96.7
ASTM Motor Dist.		
Distillate + Loss %		
@ 158°F.	18.5	20
@ 212°F.	38.0	39
EP, °F.	401	410
Recovery—%	97.5	98
Cracked Gas Oil Properties		
Gravity, °API	22.7	29.0
ASTM 50% dist, °F.	605	481
Aniline Point, °F.	124	113

rels of isobutane is produced as compared with the 134 barrel butane deficit experienced with the thermal gas oil cracking operation. These figures aptly illustrate the extreme adaptability of catalytic cracking to aviation gasoline production. Not only does the catalytic process provide large yields of high quality base stock, but also high accompanying yields of isobutane and olefins for alkylations, and isopentane for direct aviation gasoline blending.

Summarized Refinery Processing Operations

Table 2 presents a summary of the pertinent figures connected with the processing operations of Figures 4, 7, and 11, covering:

a. Conventional pre-war crude distillation and thermal cracking operations.

b. Conventional pre-war crude distillation and thermal cracking operations augmented by pentane fractionation, butane-pentane alkylation and butane isomerization.

c. Conventional crude distillaton and thermal operatons modified as in (b) above, with catalytic gas oil cracking substituted for thermal gas oil cracking.

As previously stated, the yield figures of the flow diagrams have ignored secondary production quantities and losses in order to simplify the overall process comparison. Recognizing this point, reference to the table shows for a 10,000 barrel run of the particular crude chosen and particular processing operations used:

1. Addition of alkylation and isomerization operations to conventional pre-war crude distillation and thermal cracking operations doubles the aviation gasoline production, while raising the gasoline octane rating (AFD — 1C+ 4 cc TEL from 91 to 100.

2. In order to achieve this production, additional normal butane must be obtained from outside sources for isomerization plant feed.

3. Substituting two-pass catalytic cracking for recycle thermal gas oil cracking again doubles the aviation gasoline production.

4. With catalytic cracking, a surplus of 436 barrels of isobutane results as compared with a butane deficit of 134 barrels for thermal cracking.

5. Aviation base stock production from the catalytic cracking operation is of considerably higher quality than the virgin base stock.

6. In going from the conventional pre-war operation to full scale aviation gasoline production, components remaining for motor gasoline production are cut in half.

7. The percentage of C_4 and C_5 fractions available for motor gasoline blending drops from some 23% of the total motor gasoline components in the case of conventional pre-war operations, to some 7% for the case of large scale catalytic aviation gasoline production.

8. A marked increase in aviation gasoline production causes only a relatively small reduction in total distillate and residual fuel production.

It should be emphasized that the figures of Table 2 are illustrative only, and are in no way intended to present a completely balanced refining operation which would, of course, take into consideration secondary yields and losses, and account for properly treated and blended finished motor gasoline production. The schedule does show the general effect on availability and quality of other refining products of increased aviation gasoline production, and the importance of catalytic cracking in the war-time aviation gasoline program. Yields used are conservative. In many cases it would be possible to substantially increase the yield of 100 octane gasoline over that indicated by employing such additional operations as propylene alklation, thermal recracking of catalytic cycle stock, pentane and hexane isomerization, etc.

Catalytic Cracking for Motor Gasoline Production

In a review of this character, it should not be amiss to pause for a minute to look into the future.

One of the outstanding charactertistic of catalytic cracking processes is their ability to produce high quality motor fuels from a wide variety of charging stocks. This feature is illustrated in Table 3, which presents the results of catalytically cracking by two different processes for the production of some 46% of motor gasoline.

The clear CFR motor octane of the two gasolines are 12 to 15 points higher than would be obtained by conventional thermal cracking of the same stocks, and the clear research ratings 14 to 18 points higher. Lead susceptibilities are also excellent.

Catalytic gasolines of this character have good stability, and normally need only caustic washing and the addition of an inhibitor for motor gasoline use. In cases of high sulfur feed stocks, a light acid test may also be required.

Considerable quantities of olefins and isobutane are also produced, along with an excellent grade of gas oil.

Many of the catalytic cracking units now on war-time aviation gasoline production will be converted to motor gasoline production in the post-war period. It is obvious that such conversion will play an important role in markedly increasing the overall quality of post-war motor fuels.

Union Oil Advances Stromberger and Corrie

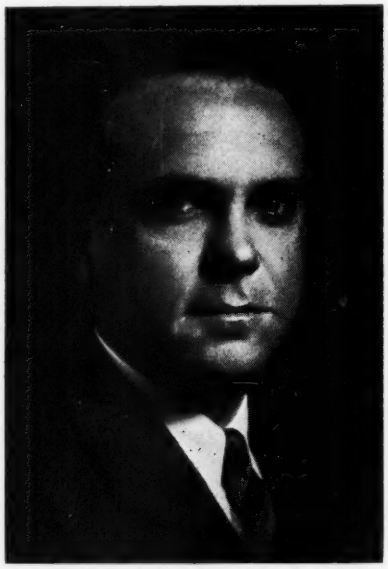
Appointment of Miss Margaret Corrie as Public Relations Representative of Union Oil Company of California was announced November 1 by Reese H. Taylor, president. She will be responsible for institutional advertising, stockholder and management bulletins, annual and quarterly reports to stockholders and employees, reporting to Mr. Taylor.

Miss Corrie joined Union Oil Company approximately five years ago, after having been for a short time with the Consolidated Steel Corporation in Los Angeles. As a result of her work at Consolidated, she obtained a leave of absence from Union during the early months of the war to serve as special administrative assistant to the chief of the Iron and Steel Branch of the War Production Board.

Later she was called back from Washington to handle many details of Union's major institutional advertising campaign being carried in newspapers throughout the Pacific Coast. Her appointment as public relations representative marks the first key executive position to be held by a woman in the 53 years of Union's corporate existence.

Miss Margaret Corrie

T. L. Stromberger, a member of Union Oil Company's advertising and publicity staff since June, 1929, has been appointed Advertising Sales Representative for the company. He will handle product and service advertising, direct the publication of Union's "Dealer News" and many other sales promotional activities, reporting to Arthur C. Stewart, vice president in charge of sales.



T. L. Stromberger

The Use of Natural Gas Components in Refinery Operations

By A. H. Boultbee
of the Shell Oil Company, Incorporated

Summary

The modern trend in petroleum refining involves the separation of stocks into individual compounds or classes of compounds and the use of these separated components by blending directly into finished products or as raw materials for specific chemical processes. This trend is discussed from the view point of its application to the present uses of natural gas and stabilized natural gasoline. The requirements for war have accelerated this trend in the direction of producing war materials such as aviation gasoline and this aspect is emphasized in the discussion. The dependence of the production of high octane components for aviation gasoline on iso and normal butane from the natural gas is illustrated. The production of toluene and the possible production of chemicals and butadiene from natural gas are briefly outlined.

* * *

Natural gas and stabilized natural gasoline were originally used, respectively as fuel gas and gasoline, without appreciable processing. This followed the usual procedure in the industry where straight run or cracked products were handled in rather wide boiling range fractions, the boiling range designating whether the fractions were destined for fuel gas, gasoline, kerosene, etc. The demand for increased product quality, together with increased demand for and increased diversification of products derived from petroleum, has, during the past ten years, resulted in a more detailed consideration of the properties and potentialities of the individual compounds present in these wide boiling range fractions.

The application of these considerations to refinery operations has required processes whereby the available stocks are separated into fractions containing the individual hydrocarbons or classes of hydrocarbons. The most common methods for effecting these separations are, of course, distillation, absorption and solvent extraction. After separation the properties of these components can be used to their best advantage either by blending into various finished products or as raw materials for specific chemical processes whereby they are converted into more useful compounds.

Natural gas and stabilized natural gasoline have been in the foreground of this development, because they are relatively simple to break down into their actual hydrocarbons. This is because they are low boiling and straight run materials and, as a result, contain relatively few hydrocarbons in comparison with higher boiling and cracked stocks. In the following are outlined the present uses of natural gas and natural gasoline with a view to illustrating the application of this trend in petroleum technology. The requirements for war have accelerated development in the direction of producing war materials such as aviation gasoline with the result that the illustrations emphasize this aspect. Wartime secrecy regulations necessarily restrict this paper to what is being or can be undertaken without discussing process details.

The hydrocarbons present in natural gas and gasoline have two characteristics required for aviation gasoline; namely, within limits, they have a desired volatility and they are inherently resistant to gum formation from atmospheric oxidation. However, besides these two qualities it is essential that aviation gasoline have a satisfactory engine performance which can, at least qualitatively, be defined as having a high A.S.T.M. motor method octane number. The modern trend, therefore, is to separate natural gasoline into those components most useful for aviation gasoline from the viewpoint of volatility and octane number and to use the rejected components as feed to chemical processes for conversion to more useful components of aviation gasoline or other refinery products.

In order to make the best use of natural gasoline it is therefore desirable to break it down into its individual components and consider the volatility, octane number and potential chemical reactions of each component.

In Table I below is shown an esti-

FIGURE 1

BOILING POINT, OCTANE NUMBER AND ESTIMATED VOLUME PER CENT OF COMPONENTS PRESENT IN A COMPOSITE CALIFORNIA UNSTABILIZED NATURAL GASOLINE

Compound	B.P., °F.	Unleaded (1) Octane Number	Vol. %
Methane Ethane	- 258.5 - 128.2	- -	0.5
Propane	- 43.8	100	7.5
Isobutane	+ 13.5	99	8.5
n-Butene	+ 31.0	92	28.8
Isopentane	82.4	90.3 (103.5)	11.3
n-Pentane	97.0	61.9	9.9
Cyclopentane	120.9	85 (141)	0.9
Branched hexanes	136-145	73-94	7.5
n-Hexane	155.8	26	3.9
Methyl cyclopentane	161.2	80 (99)	2.4
Benzene	176.2	106 (90.5)	0.7
Cyclohexane	177.4	78.6 (97)	1.1
Dimethyl cyclopentanes	189.5-210.6	89	3.0
Branched heptanes	174-199	45-93	3.2
n-Heptane	209.1	0	1.6
Branched octanes	210.7-246	23-103	-
Methyl cyclohexane	213.4	73 (84)	1.5
Toluene	231.3	104 (107)	0.7
n-Octane and heavier	258.3	- 17	7.0
			100.0%

(1) Values in brackets refer to blending octane numbers.

mated component composition of a composite California unstabilized natural gasoline as received from several fields at a refinery, together with the boiling point and octane number of the individual compounds. Because of the large number of individual hydrocarbons and the difficulty of separating them, the estimated composition may be considerably in error for some of these components. However, it is probable that the table indicates the correct order of magnitude of the component concentrations. The total composition was made to total 100 per cent even though it is realized that a few possible components are ignored and no attempt has been made to estimate the large number of possible hydrocarbons in the high boiling 7 per cent of this gasoline.

Referring to the table it can be observed that propane, while having an excellent octane number, is very low boiling with the result that very little can be included in gasoline without exceeding the maximum vapor pressure specification. Iso and normal butane also have excellent octane numbers and their boiling points are such that appreciable quantities can be included. However, isopentane, being nearly as good in octane number and appreciably higher boiling, is a more desirable component. If a given aviation gasoline, deficient in volatility, is to be made up to the maximum vapor pressure with one of these components, the relative volumes of these components that can be added are:

Propane	1.0
Isobutane	2.9
n-Butane	4.1
Isopentane	11.7

Thus a greater volume of finished aviation gasoline will result when the vapor pressure is made up with isopentane than with any of the other components. For this reason butanes would only be included in aviation gasoline if there were a deficiency of isopentane in the refinery.

Proceeding to the higher boiling components it can be observed that normal pentane has a much lower octane number than the preceding compounds. For this reason it has been the practice for some years to separate it from isopentane and the higher boiling natural gasoline in order to eliminate it from aviation gasoline. Fractional distillation is used to effect this separation and columns of 80 plates are considered desirable for economic operation. The normal pentane so rejected has been generally diverted to motor gasoline where the octane number requirements are lower than for aviation gasoline. However, recently processes have been developed whereby this normal pentane can be converted to isopentane. The processes employ catalysts and operate at moderate pressures and temperatures. Unreacted n-pentane is separated from the synthesized isopentane by fractional distillation and returned to the process. By this means an ultimate yield of 95 per cent of isopentane can be obtained.

The next higher boiling components of natural gasolines are cyclopentane and branched or isomeric hexanes. In general, these have high octane numbers and are attractive components of aviation gasoline. Cyclopentane is particularly attractive as it has a very high blending octane number. Normal hexane, boiling above the branched hexanes, has a very low octane number and is rejected by some refiners by precise fractionation. However, it is so close in boiling range to other high octane components that it is not practical to make a pure normal hexane reject which would have an octane number of 26. A reject of 55 octane number material is being achieved using towers of 70-80 plates.

Proceeding to still heavier components it can be observed that the normal paraffins are unattractive, that the branched paraffins and cyclo paraffins vary in attractiveness and that the aromatic hydrocarbons, benzene and toluene, are excellent components. However, the increasing number of components boiling close together make it generally uneconomic to prepare additional reject streams by straight fractional distillation. With certain types of natural gasoline deficient in cyclo paraffins and aromatics such operation can be attractive however.

The material in natural gasoline boiling above toluene is of relatively poor octane number and is generally rejected by direct fractionation. The exact boiling point above which a refiner will reject the heavier components will vary with the overall refinery balance and other uses for the heavier components.

A graphical picture of the octane number distribution is presented in Figure 2. This shows a distillation curve from an exhaustive laboratory fractionation of a stabilized natural gasoline together with the octane numbers and gravities of the fractions.

The first high octane peak corresponds to isopentane and is followed by a low octane valley of normal pentane. The next octane peak corresponds to cyclo pentane and branched hexanes. The dip in the gravity curve indicates the presence of cyclo pentane. The stepwise change from peaks to valleys is because of the limitations of the fractionating equipment which results in fractions containing both the low and the adjacent high octane compounds. The next valley corresponds to normal hexane followed by a peak from benzane and methyl cyclopentane. Again the gravity dip indicates cyclic compounds. A valley in the normal heptane range rising to a peak at toluene followed by a valley conforms in general to the lower boiling pattern but emphasizes the difficulty of using straight fractionation for effecting separation in the higher boiling range.

Demands for toluene for T.N.T. have resulted in the installation of plants for separating it from natural and straight run gasolines. Ordinary distillation would require a prohibitive number of trays and a prohibitive quantity of reflux to separate the toluene from the non-toluene hydrocarbons. Accordingly, a toluene concentrate is first produced by direct fractionation and the concentrate is then distilled in the presence of a third component which is generally a non-hydrocarbon polar compound. This component changes the volatility ratio of the toluene and the non-toluene hydrocarbons so that their separation can be effected with an economic number of trays and quantity of reflux. The third component leaves the column with one of these products, is separated therefrom by ordinary distillation on another column, in some cases preceded by an extraction step; it is thence returned to the original column. By such means 90 per cent of the toluene in a concentrate can be obtained at nitration grade purity of 99 per cent.

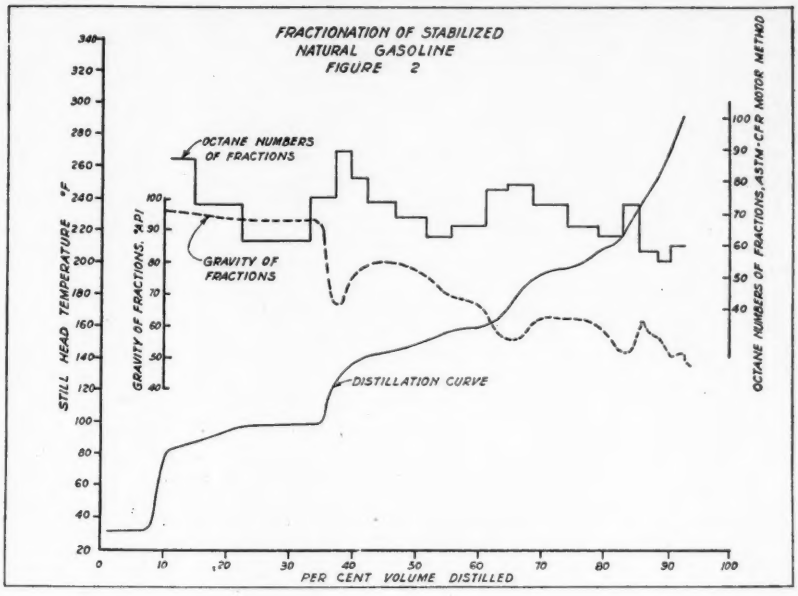
The foregoing has dealt primarily with the utilization and separation of natural gasoline components by physical methods. In discussing the chemical processing of these hydrocarbons it would be advisable to revert to the development of isooctane and related compounds as commercial components of aviation gasoline.

Feed stock for the early processes for manufacture of these high octane components was the butane-butylene stream which in turn was a by-product of thermal cracking operations. As demand for these components increased, the supply of the necessary feed stock from thermal cracking became inadequate. In the following a brief resume is made of developments in this field in order to demonstrate how a changing technology allowed the increased requirements of feed stocks to be obtained from natural gasoline, and to illustrate quantitatively how this resulted in greatly increased aviation gasoline manufacture .

In 1935 the first commercial isooctane was manufactured by Shell at Martinez, California. In the original process a butane-butylene stream was contacted with cold sulfuric acid in which the isobuty-

lene was absorbed. The residual isobutylene free butane-butylene stream was rejected to motor gasoline. The "fat acid" was removed continuously and heated to a moderate temperature where separation of a polymer occurred. The lean acid was cooled and returned to the absorption step. The separated polymer was distilled for recovery of an octylene which was subsequently hydrogenated to yield isooctane. In 1936 this process was modified in that the contacting was carried out at a moderate temperature. Under these conditions approximately an equal quantity of normal butylene reacted with the isobutylene and a polymer immediately separated. The octylenes so produced were, after hydrogenation, nearly as high octane number as those in the original process (98 compared with 99) and the yield of octanes from a given cracking intake, from which the butylenes were by-products, was more than doubled. The reason the yield was more than doubled was that the precentage of butylene converted to polymer heavier than octylene was in the hot acid process less than half that produced in the cold acid process. In Figure 3, Cases A and B, is given a comparison of volume yields of high octane product for these two processes. There is also given a comparison of the "octane barrels" produced from a given quantity of feed. The "octane barrels" are obtained by multiplying the octane number of the product by the barrels of product produced. To a first approximation the result can be used as a relative measure of the amount of finished aviation gasoline that can be blended from the products of the processes being considered and the relationship allows comparisons to be made of several processes where both the quantity and octane numbers of the products vary. The U.O.P. selective polymerization process produces results similar to the hot acid process but uses a vapor phase reactor containing solid phosphoric acid catalyst.

In 1938 the alkylation process was developed wherein butylenes and isobutane were contacted with concentrated sulfuric acid; the isobutane and olefin reacted to form saturated hydrocarbons in which octanes predominated. The isobutane had to be present in large excess in order that it would react with the butylene to form a non-reactive product before the butylenes had an opportunity to polymerize. Again the octane number was inferior to that obtained in the other two processes (94) but this was more than compensated for by the increased volume of octanes (including small amounts of other high octane number hydrocarbons) from a given refinery cracking intake. This relative increase over that obtained with the cold and hot acid polymerization processes is shown in Figure 3, Case

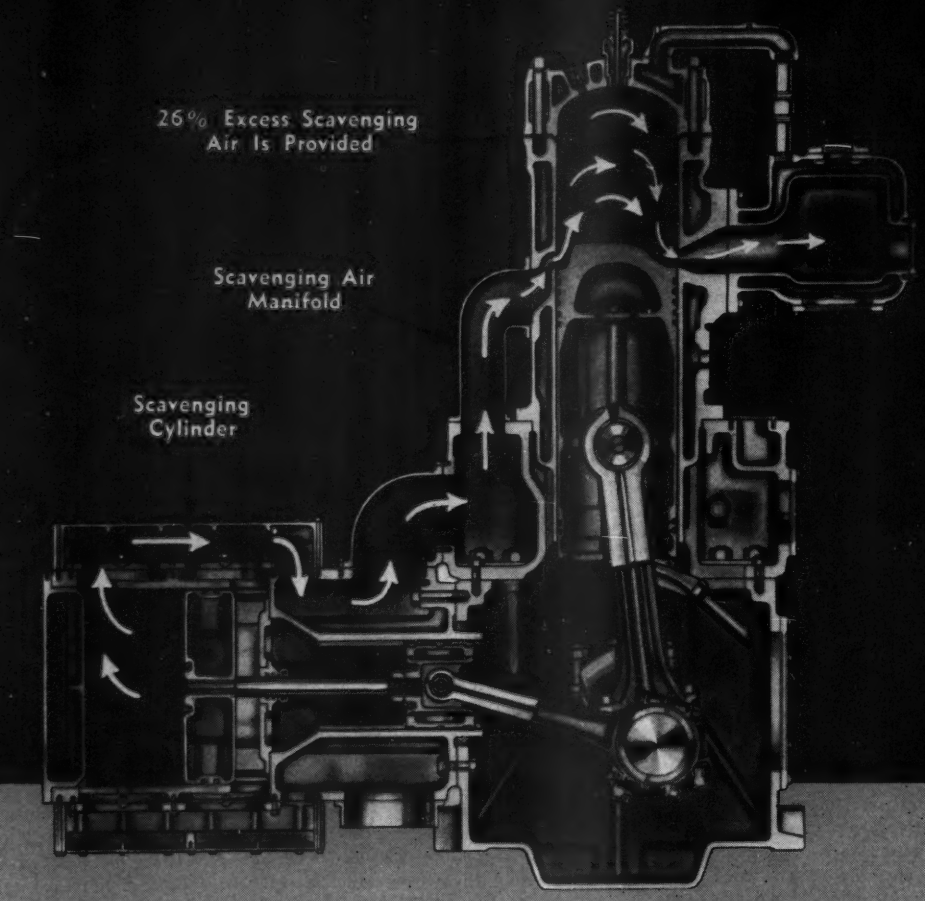


C, wherein the total butylenes reacted is the same as in Case B. Again this increase is more than doubled over that with the hot acid process because less butylenes are converted to high boiling material. Moreover, normal butylene is present in refinery gases in excess of isobutylene but its utilization in the polymerization process was limited to an amount equivalent to the isobutylene present. Polymerization of amounts in excess of this resulted in a lower octane number hydrogenated product. However, the alkylation process could make use of all the iso and normal butylenes, thereby further increasing the yield of octanes obtainable from a given quantity of butane-butylene. This is shown in Figure 3, Case D. In addition, propylane and the amylenes are being used as alkylation feed stocks thereby producing alkylates somewhat lower in octane number than butylene alkylate (89 and 92, respectively, compared with 94) but yielding a greatly increased volume of alkylate. (Figure 3, Case E.) Now sufficient isobutane to alkylate these olefins is not present in refinery cracked gases. Accordingly, recourse to that present in unstabilized natural gasoline was made and its use is responsible for the greatly increased demand for isobutane recovery in the fields that started in 1938-39.

To illustrate the importance of the isobutane from natural gasoline it can be observed that, from a given quantity of butane butylenes, there is a three-fold increase in octane barrels when converting from the hot acid process to alkylation (Figure 3, Cases B and D). Moreover, if the propylene and amylenes concurrently produced in thermal cracking are also alkylated, this increase becomes seven-fold (Cases D plus E). However, the isobutane requirement in the latter case is eighteen times that available from thermal cracking and so this increased production of aviation components can only be realized if isobutane from other sources is available. The alkylation reaction not only requires a high isobutane olefin ratio, which is obtained by recycling, but it produces a higher yield of a better quality if the reactor concentration is high in isobutane. For this reason normal butane, which is unreactive and acts as a diluent, was undesirable and accordingly the request to the fields was for isobutane low in propane and n-butane. This purification is, of course, made in the refinery where facilities and transportation permit.

The increased demand for aviation gasoline as a result of the war has resulted in the construction of catalytic cracking units which produce high grade aviation base stock together with large quantities of propylenes, butylenes and amylenes. To alkylate these olefins requires larger quantities of isobutane than are available in the fields. Accordingly, concurrently with the construction of the catalytic cracking units, there has been the construction and operation of butane isomerization plants. These plants are similar to those mentioned above for pentane isomerization. To provide feed stock for these plants recourse has been made to the normal butane in unstabilized natural gasoline.

From the aforementioned outline it can be seen that alkylation is limited to the quantity of olefins available as by-products from cracking units. However, since 1941 commercial operation of bu-



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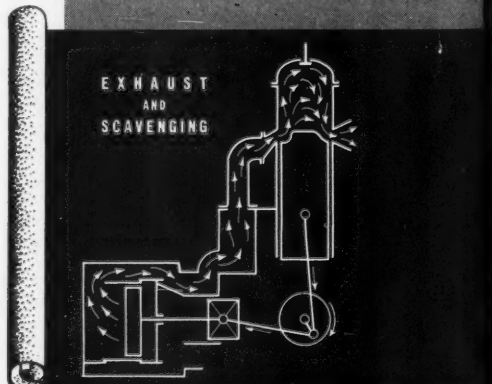

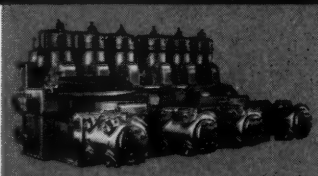

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tane dehydrogenation plants has been carried out whereby butanes are converted to butylenes. In this process iso or normal butane or a mixture of the two is passed over a catalyst at elevated temperatures and low pressure. Unconverted butanes are recycled for an ultimate conversion to butylenes of 80 per cent. Thus, alkylate is being produced directly from natural gas components and so can be made independent of other refinery operations such as cracking intakes. While not in commercial use, this process can also be applied to the production of propylene from propane and probably for amylenes from n-pentane.

For a number of years organic chemicals have been produced from the low boiling olefins obtained as a by-product of thermal cracking. Thus, propylene from thermal cracking has been used as raw material for manufacturing isopropyl alcohol, acetone, mesityl oxide, methyl isobutyl ketone, diacetone alcohol and isopropyl ether. Butylenes from the same source have been used to produce secondary and tertiary butyl alcohol and methyl ethyl ketone. Recently, cumene for use as an aviation gasoline blending component has been manufactured from propylene and benzene and butadiene for synthetic rubber has been manufactured from butylene. The above is only a very short list of the commercial organic chemicals that can be and are being manufactured from the low boiling olefinic hydrocarbons. The demand for these chemicals has to compete for the olefinic raw material with other demands for these raw materials such as aviation gasoline as outlined earlier. Moreover, since most of the available olefins are by-products of cracking operations, their availability is dependent on the demand for other cracked products such as motor gasoline. However, by use of the aforementioned dehydrogenation process the olefinic raw materials can be produced directly from components of natural gas independently of cracking operations and in greatly increased quantities. As many of these chemicals are, in their turn, raw materials for the plastic and synthetic fibre industries, it is possible that natural gas utilization will tend in this direction as post war markets develop.

Reference has already been made to the separation of toluene from straight run gasoline including natural gasoline. Processes are also in use in which fractions of straight run and natural gasoline distilling in the toluene range are treated catalytically to produce synthetic toluene from the other hydrocrabons

FIGURE 3

COMPARISON: YIELDS OF AVIATION COMPONENTS WITH DIFFERENT PROCESSES

Basis: 10 bbl. isobutane
20 bbl. isobutylene
30 bbl. n-butylenes
40 bbl. n-butane
100 bbl. total butane-butylene
35 bbl. propylene) concurrently in
48 bbl. amylenes) other streams

Case	Process	Olefins Type	Olefins Bbl.	Iso-butane Bbl.	Saturated Aviation Product Bbl.	Saturated Aviation Product O.N.	Octane Bbl.	Heavy Non-Aviation By-Product, Bbl.
A	Cold Acid	Iso-butylene	20	None	11	99	1,089	3.2
B	Hot Acid	Iso-butylene	20)	None	27.8	98	2,720	4.5
		n-butylene	20)	None				
C	Alkylation Same olefins as B	Isobutylene	20)	54	69	94	6,500	3.2
		n-butylene	20)					
D	Alkylation All butylenes in charge	Isobutylene	20)	67	87	94	8,170	4.1
		n-butylene	30)					
E	Alkylation propylene & amylenes	Propylene	35	47	55	88	4,850	3.2
		Amylenes	48	65	74	92	6,800	6.7
	Total D & E		133	179	216		19,820	14.0

present. The synthetic toluene so produced, together with the natural toluene originally present, are then separated in nitration grade purity from the unconverted or non-reactive hydrocarbons by distillation with a third component as discussed above. Liquid extraction has also been used to separate toluene from non-toluene hydrocarbons. The addition of synthetic toluene manufacture to the natural toluene recovery increases by several fold the amount of toluene that can be obtained from a given quantity of natural gasoline. While this process is primarily designed to produce toluene for T. N. T., the toluene can be diverted to aviation gasoline. The reject from the toluene process is material having an octane number of less than 65 and contains much of the normal heptane in the original charge. Thus a separation and rejection of low octane number components has been made and concurrently compounds having only fair octane numbers have been converted to toluene which has a high octane number (107).

The plants designed for producing synthetic or natural toluene may be converted to the production of synthetic and natural benzene if sufficient demand should develop for the latter product.

In review, therefore, the current uses of natural gas and gasoline components can be summarized as follows:

Propane: As fuel (including liquefied petroleum gases) but can be converted to propylene as soon as economic considerations warrant it. Propylene in turn is a raw material for alkylation or for chemical manufacture such as isopropyl alcohol.

Iso-Butane: As alkylation feed stock whereby it becomes a key component in aviation gasoline manufacture.

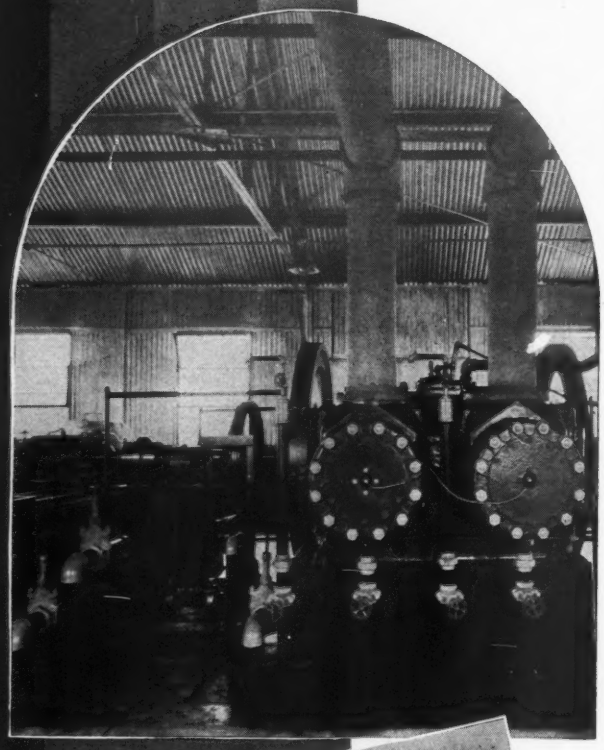
n-Butane: As feed to isomerization plants whereby it is converted to isobutane. Alternatively, it is being converted to butylenes thus becoming the other principal alkylation feed stocks supplementing butylenes from other sources. As such, it contributes to aviation gasoline manufacture but can alternatively be diverted to the manufacture of butadiene for rubber or to butyl alcohol, ketones and other chemicals.

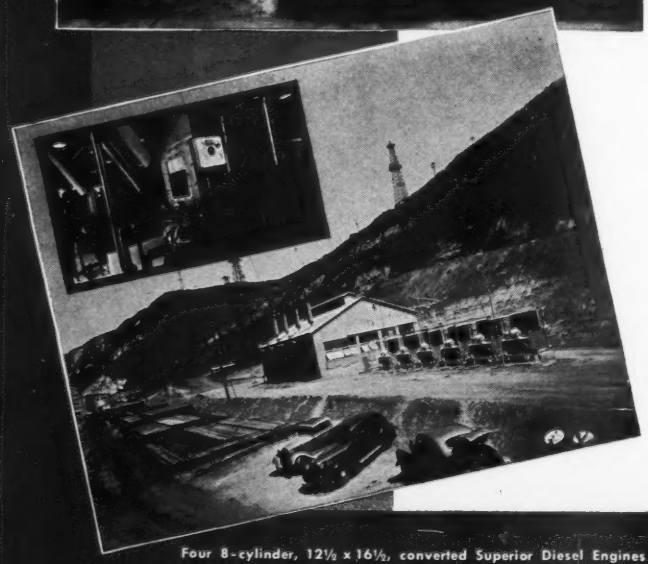
Isopentane: Used as such as a key component in aviation gasoline because it combines desired octane number with desired volatility.

n-Pentane: Separated and relegated to motor or second grade aviation gasoline. Alternatively, is to be used as feed

(Continued on Page 34)

What are Your Oil Field Power Requirements?





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The Absorption Factor in Controlling The Absorption Process

By
Randal Maass, Refinery Engineer
General Petroleum Corporation of California

Introduction

The California Natural Gasoline Association is justly proud of having been the medium through which the absorption factor was introduced to the industry. It was at the regular C. N. G. A. meeting of February 1930 that Mr. Alois Kremser, of the Standard Oil Co. of Calif., presented the theoretical basis of this concept. The value of the absorption factor was immediately recognized as an instrument for the design of absorbers as well as a tool for the control of absorption. This recognition was not limited to the west but spread across the nation. Many other workers in the field, notably Dr. Brown, Horton & Franklin, and Edmister, have adopted the concept and have developed its uses. The highest recognition of his contribution came in 1941, when he received the Hanlon Award, from the Natural Gasoline Association of America.

FIGURE 1
NOMENCLATURE FOR ABSORPTION EQUATION DERIVATION

L = Mols of oil
V = Mols of gas
y = Concentration in the gas phase
x = Concentration in the liquid phase
K = Equilibrium constant y/x
A = Absorption factor L/VK
n = Number of equilibrium plates

Subscripts:
0 refers to the lean oil
1,2,3 or 4 refers to gas from or oil from the plates numbered from the top of the absorber
w refers to the wet gas

The present paper will briefly review the derivation of the absorption factor somewhat along the lines originally used by Mr. Kremser. In addition it will also review the applications of the absorption factor to the control of absorption processes.

Derivation of the Absorption Equation

The original derivation of the absorption equation was based on the treatment of a relatively lean gas in which the shrinkage through the absorbers could be neglected, that is, the volumes of gas and oil were considered constant throughout the absorbers. With no appreciable absorption, the temperatures were also considered constant throughout the absorbers. Figure 1 lists the nomenclature used in the derivation. The derivation itself is tabulated in Figures 2 & 3. Considering one constituent only, material balances are made around each plate and around the entire absorber. These material balances are expressed in gas concentrations, using the equilibrium constant expression to convert liquid concentrations to gas concentrations. By combining these balances Equation 5 is obtained. Equation 6 is similar but more general expression for an absorber with "n" equilibrium plates. The term "y_0" represents the concentration of the constituent in a gas in equilibrium with the lean oil. If it is assumed that the lean oil is completely stripped of this constituent, "y_0" is equal to zero. The resulting equation 7 gives us the fraction absorbed as a function of the term

$$\frac{\text{"L"}}{VK}$$

and the number of equilibrium plates in the absorber. Knowing these two terms the equation can be solved by means of Figure 4. Since for any one absorber, the number of equilibrium plates may be considered constant, the fraction absorbed therein is a function of the term

$$\frac{\text{"L"}}{VK}$$

FIGURE 2
DERIVATION OF THE ABSORPTION EQUATION

1. $V(y_2-y_1) = L(x_1-x_0)$ Material balance around plate No. 1
2. $K = y/x$ Definition of equilibrium constant
3. $V(y_1-y_w) = L\left(\frac{y_1}{K}-\frac{y_0}{K}\right)$ Material balance around plate No. 1
4. $(y_2-y_1) = \frac{L}{VK}(y_1-y_0)$ Material balance around plate No. 1
   $(y_3-y_2) = \frac{L}{VK}(y_2-y_1)$ Material balance around plate No. 2
   $(y_4-y_3) = \frac{L}{VK}(y_3-y_2)$ Material balance around plate No. 3
   $(y_w-y_4) = \frac{L}{VK}(y_4-y_3)$ Material balance around plate No. 4
   $(y_w-y_1) = \frac{L}{VK}(y_4-y_0)$ Material balance around a 4 plate absorber

alone. This term, upon which the fraction absorbed depends, Mr. Kremser has called the Absorption Factor or "A".

Significance of the Absorption Factor

The practical conclusion that may be drawn from the absorption equation is that if the term

$$\frac{\text{"L"}}{VK}$$

is maintained constant in any one absorber the fraction of the constituent absorbed will also remain constant. Analyzing the term

$$\frac{\text{"L"}}{VK}$$

we see that it is made up of two parts, the oil to gas ratio

$$\frac{\text{"L"}}{V}$$

and an equilibrium constant "K".

The $\frac{\text{"L"}}{V}$ oil to gas ratio, if you remember the nomenclature in Figure 1, is expressed as a ratio of the mols of oil to the mols of gas. In the plant, however, oil to gas ratios are measured as gallons or barrels of oil per M. C. F. of gas. These ratios can be readily converted to the model ratio by the following expression:

$$\frac{L}{V} = 3.16\,\frac{d}{M}\,\frac{O}{G}$$

Where:
d = Specific gravity of the lean oil at 60° F.
M = Molecular weight of the lean oil.
O/G = Gallons of oil per MCF of gas.

Refinery Engineers can multiply the

FIGURE 3
DERIVATION OF THE ABSORPTION EQUATION
(Continued)

5. $\frac{y_w-y_1}{y_w-y_0} = \frac{\left(\frac{L}{VK}\right)^5-\left(\frac{L}{VK}\right)}{\left(\frac{L}{VK}\right)^5-1}$ Absorption Eq. for a 4 plate absorber

6. $\frac{y_w-y_1}{y_w-y_0} = \frac{\left(\frac{L}{VK}\right)^{n+1}-\left(\frac{L}{VK}\right)}{\left(\frac{L}{VK}\right)^{n+1}-1}$ Absorption Eq. for "n" plate absorber

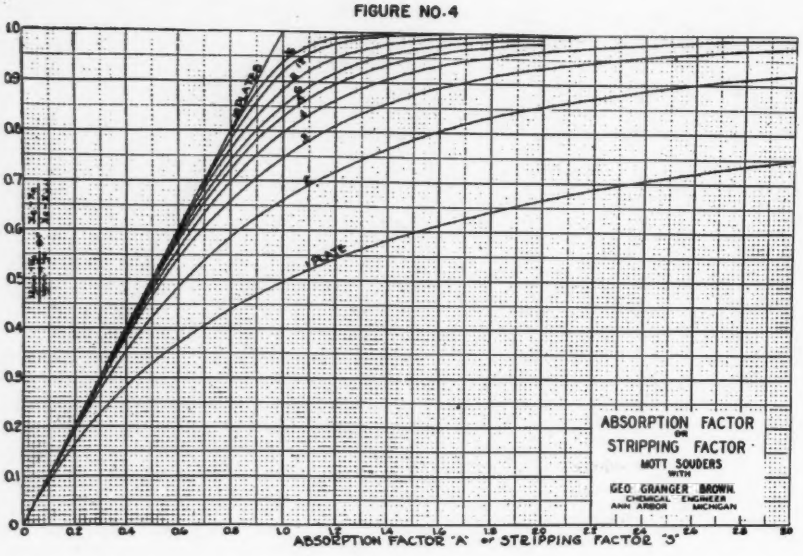
FOR A COMPLETELY STRIPPED OIL

7. $\frac{y_w-y_1}{y_w}$ = Fraction absorbed = $\frac{\left(\frac{L}{VK}\right)^{n+1}-\left(\frac{L}{VK}\right)}{\left(\frac{L}{VK}\right)^{n+1}-1}$

8. $A = \frac{L}{VK}$

9. Fraction absorbed = $\frac{A^{n+1}-A}{A^{n+1}-1}$

FIGURE NO. 4



constant in the above equation by 42, if they wish to express the oil to gas ratio in barrels per MFC. The term

$$\frac{\text{"d"}}{\text{M}}$$

is readily evaluated since the gravity of the oil is easily obtained and the gravity together with the boiling range will furnish the molecular weight from a chart such as the one presented in Figure 5.

The second part of the absorption factor, or

$$\frac{\text{"L"}}{\text{VK}}$$

term, is the equilibrium constant which depends upon three variables; namely, the constituent under consideration, the pressure, and the temperature. Curves of equilibrium constants for the various hydrocarbons as functions of temperature and pressure have been published in the literature. One such curve for isobutane is presented in Figure 6.

The expression for the absorption factor may now be written in the following more practical form:

$$A = 3.16 \frac{d}{M} \frac{O}{G} \frac{1}{K}$$

Application to Control

Analyzing the above expression we see that the absorption factor depends upon five variables; namely, the quality of the oil, the oil to gas ratio, the absorber pressure, the absorber temperature, and the constituent under consideration. In operation, however, most of these variables can be kept constant or very nearly so. We can eliminate one variable by focusing our attention only upon the key component, that is, the component we are stretching our plant, so to speak, to extract. Under the present refinery demands this key component is isobutane. If you should be interested in the absorption factors for the remaining constituents, they will be inversely proportional to their equilibrium constants.

In the operation of the absorbers the pressure is always controlled to within close limits, thereby eliminating the pressure as a variable. Also if the oil stripping equipment is adequate, the quality of the lean oil is quite constant. With three of the variables held constant, only two remain variable; that is, the oil to gas ratio and the absorber temperature.

Practically speaking then, to maintain a constant percentage absorption or, what amounts to the same thing, a constant absorption factor, it is necessary to change the oil to gas ratio to accommodate changes in the absorber temperature due to fluctuations in the degree of cooling obtainable. The changes in absorber temperatures will be reflected in changes of the equilibrium constant. To repeat, as the absorber temperature changes the equilibrium constant will change and the oil to gas ratio must be changed to maintain a constant absorption factor.

This balance between the oil to gas ratio and the equilibrium constant changes with temperature may be handled in the plant in several ways with varying degrees of accuracy. The most precise method of operation would be to furnish the operator with the factor

$$\frac{\text{"3.16 d"}}{\text{M}},$$

which is being held constant, and with a curve or table of equilibrium constants for various temperatures. Then, as the temperature changes, the operator can select the proper equilibrium constant and can change the oil to gas ratio to maintain the present constant absorption factor. The operators get a great deal of satisfaction out of controlling the absorbers in this fashion; however, if it is felt that the computations should not be performed by them, the operating engineer can prepare a curve or a table showing the proper oil to gas ratios for the various absorber temperatures. For example, let us assume that we wish to extract 90 per cent of the isobutane available in the wet gas coming to the plant. Because the rich oil from the absorber will be vented at a lower pressure and partially reabsorbed in another absorber with a consequent loss of some of the isobutane originally absorbed, it will be necessary to overabsorb in the first absorber to compensate for the loss. Let us assume an extraction of 94 per cent will be necessary to compensate for the various cycle losses. Figure 4 shows that with a 4 equilibrium plate absorber an isobutane absorption factor of 1.64 will be required to obtain this extraction. Solving the absorption factor equation for the oil to gas ratio the following is obtained:

$$O/G = \frac{A\,K}{3.16\ \frac{d}{M}}$$

Assuming we are using a 36° A. P. I. oil with a molecular weight of 174, the values of the specific gravity, molecular weight and absorption factor may be substituted in the above equation to obtain:

$$O/G = 107\ K$$

With the aid of Figure 6 and the known absorber pressure, the oil to gas ratio required for an isobutane absorption factor of 1.64 may be tabulated or plotted for various absorber temperatures. Figure 7 is such a plot based upon the data assumed above at an absorber pressure of 145 psi gauge. With the aid of such a plot as this the operator can readily set the proper oil to gas ratio for the prevailing absorber temperature.

The extraction expected from computations as indicated above should be occasionally checked by analyses of the plant outlets to directly determine the percentage extraction. The absorption factors used may then be revised in the direction the analytical results indicate. Note that any change in the absorption factor desired will require the construction of a new curve similar to Figure 7.

A more approximate method of compensation for absorber temperature changes is to set oil to gas ratios for various periods of the day according to previous observations of absorber temperatures. For example, if cooling conditions are such that the tower runs warm during the daylight hours and cool at

night, the proper oil to gas ratios could be set for each condition and the switch made at some definite time, say 6 P.M. Finally, the most approximate method is to set a constant oil to gas ratio that will yield on the 24 hour average the absorption factor that is desired. Regardless of which method is used, it is advisable to have the operating engineer occasionally compute the absorption factor taking in consideration all variables to check the more approximate methods.

To illustrate the effect of changes in absorber temperature on the absorption factor and also on the fraction absorbed, let us assume we are operating an absorber at 145# gauge and 80°F. Under these conditions a 5°F change in temperature will change the equilibrium constant, and consequently the absorption factor by 8.5 per cent. If we are attempting to extract 80 per cent of the isobutane in the feed to the absorber with a 4 theoretical plate absorber, an isobutane absorption factor of 1.0 would be required. In this range the 8.5 per cent change in absorption factor would show a 3.5 per cent change in the fraction absorbed. As the extraction is increased, the effect of temperature changes diminishes. Figure 7, on the other hand, aptly illustrates the extent to which the oil to gas ratio must be varied with changes in temperature in order to maintain a constant extraction.

So far we have assumed that we are treating a gas sufficiently lean so that changes in oil and gas volumes and absorber temperatures are negligible throughout the absorber. Practically, such conditions never exist; that is, there is always a shrinkage in gas volume through the absorber and a pickup in oil volume. It can be shown that the absorption equation,

$$\text{Fraction Absorbed} = \frac{A^{n+1} - A}{A^{n+1} - 1},$$

still holds for the conditions of finite gas shrinkage through the absorber, if the proper average value of the absorption factor "A" can be determined. In the remainder of the paper it will be shown that at least a working average absorption factor can be determined with sufficient accuracy for control purposes.

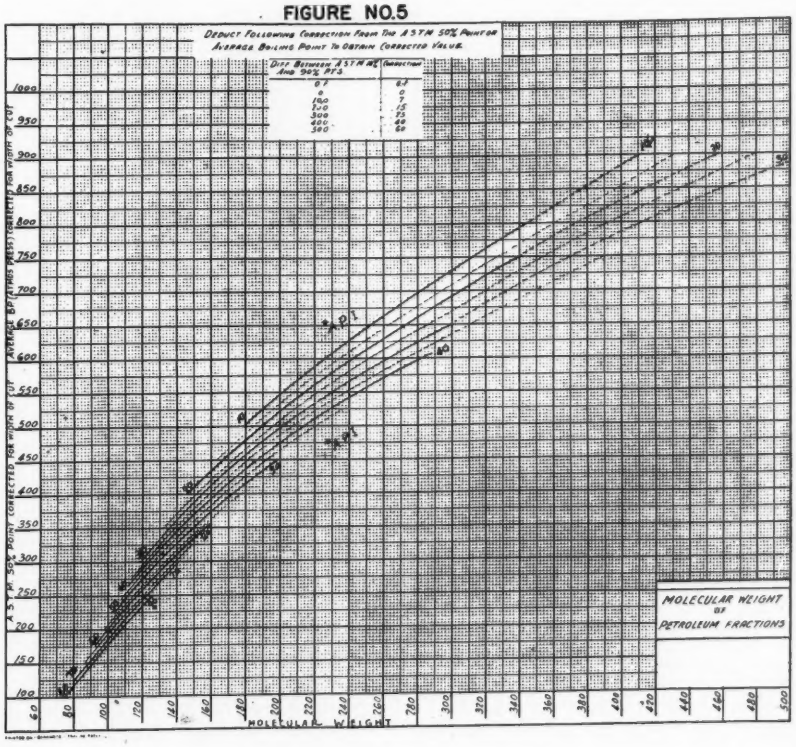
One of the effects of a finite shrinkage and finite oil pickup through an absorber is to change, in some cases, the oil to gas ratio through the absorber. Thinking in terms of mols again, a balance around each plate will show that the mols of gasoline the oil absorbed must be exactly equal to that lost by the gas in passing through the plate. Bearing in mind that the oil travels down the tower and the gas up the tower, it follows that in proceeding down the tower the molal increase in oil exactly equals the molal increase in gas. Finally, at the bottom of the tower, the mols of rich oil differs from the mols of lean oil by exactly the same amount that the wet gas differs from the dry gas. This increase in oil and gas can effect the oil to gas ratio in three different ways depending upon the magnitude of the ratio.

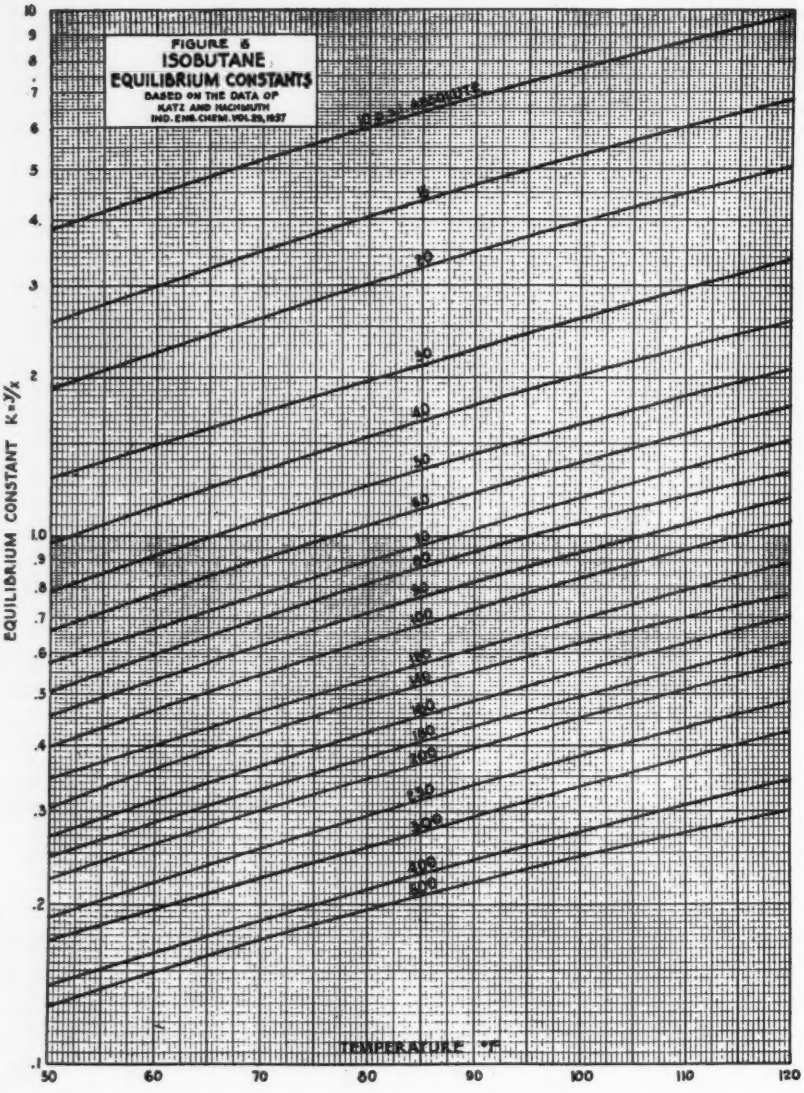
Consider first a molal ratio of lean oil to dry gas equal to 1.0 and a shrinkage equal to 25 per cent of the dry gas. At the top of the tower the ratio would be equal to 1/1 and at the bottom of the tower the ratio would be (1 + 0.25) / (1 + 0.25), or 1.25 / 1.25 which is also equal to one. Furthermore, the oil to gas ratio at any plate would be equal to (1+a) / (1+a) (where "a" equals the pickup in liquid from the top of the tower to the plate in question) which is also equal to one. Therefore, if the molal ratio of lean oil to dry gas is equal to one, the molal ratio throughout the tower will be constant and equal to one.

On the other hand, if our molal ratio of lean oil to dry gas were 2/1 with the same shrinkage, the ratio of rich oil to wet gas would be 2.25 / 1.25, or 1.8. By a similar reasoning the ratio would decrease from the top to the bottom of the tower until the ratio of 1.8 is reached. Considering a lean oil to dry gas ratio of 0.5 / 1, the opposite effect is obtained, with the final rich oil to wet gas ratio attaining a value of 0.75 / 1.25, or 0.6. This can be summarized by saying that if the molal ratio at the top of the absorber is equal to 1.0 the ratio will remain constant throughout the tower, if the top ratio is greater than 1.0 the ratio will decrease down the tower, and if the top ratio is less than one the ratio will increase down the tower. The effect of the shrinkage will be greater the further the ratio is removed from "one".

Practically then some cognizance must be taken of this changing ratio. Our problem is somewhat simplified since we are interested only in its effect upon the absorption of the key component. The components heavier than the key component are absorbed principally in the bottom of the tower; whereas, the lighter constituents are absorbed principally in the top of the tower. The absorption of the key component, however, takes place throughout the entire tower. Therefore, some kind of an average of the ratios on each plate should prove to be the effective ratio. For our purpose, that is for purpose of control, no excessive refinements are necessary to obtain a satisfactory average oil to gas ratio. The simple arithmetic average of the top and bottom ratios, that is the lean oil to dry gas ratio and the rich oil to wet gas ratio, suffices for a working average ratio to control the absorption of the key component. Although we are focusing our attention entirely upon the key com-

FIGURE NO.5





ponent, the absorption of the other components takes care of itself, since their absorption factors are proportional to that of the key component.

To obtain the average oil to gas ratio indicated above, it is not necessary to meter all four streams, the lean oil, rich oil, dry gas and wet gas. It is only necessary to meter the lean oil and the dry gas and to be able to obtain the shrinkage either by metering the wet gas or by estimating the shrinkage. If the shrinkage is expressed as a fraction of the dry gas, the average ratio can be obtained by adding one half of this fractional shrinkage to the numerator and denominator of the molal lean oil to dry gas ratio obtained from the expression:

$$\frac{L}{V} = 3.16 \frac{d}{M} \frac{O}{G}.$$

For example, using the same 36° A. P. I. absorber oil in a ratio of 50 gals / MFC of dry gas, the average oil to gas ratio may be computed as follows for an absorber having a shrinkage of 20 per cent.

$$\frac{L}{V} = 3.16 \frac{d}{M} \frac{O}{G} = 3.16 \times \frac{0.844}{174} \times 50 = 0.766$$

$$\frac{(L)}{(V)\ \text{ave.}} = \frac{0.766 + 0.1}{1 + 0.1} = 0.787$$

The same computation may be made beginning with the rich oil to wet gas ratio. In this case, however, the shrinkage must be expressed as a fraction of the wet gas volume. The use of the lean oil to dry gas ratio is preferred because both the lean oil and the dry gas can be metered more accurately than can the rich oil or wet gas. In addition, especially in refinery operations, the dry gas volumes are much steadier than are the wet gas volumes. From the above discussion we can see that the lean oil to wet gas ratio, often used in controlling absorbers, does not exist anywhere within the tower and can, therefore, lead to erroneous results.

The finite shrinkage through an absorber also raises the temperature of the oil as it passes down the tower due to a sizable heat of absorption. By the same reasoning used above, the average of the temperature on the top plate and the bottom plate can be used as an average absorber temperature for control purposes. If these temperatures are not obtainable, the dry gas and the rich oil temperatures can be assumed to reflect the temperatures of the top and bottom trays, respectively. If intercoolers are used, such temperature changes should be recognized in computing the average tower temperature.

It is apparent that the above computations are too complex to be used by the operators in the plant. Therefore, we must still control the absorbers by means of the lean oil to dry gas ratio, leaving the more involved computations for the operating engineer. To illustrate, we will recompute the data of Figure 7, assuming a shrinkage in the absorber equal to 20% of the dry gas volume. The absorption factor equation can be written to include the shrinkage correction as follows:

$$A = \frac{\left\{ 3.16 \frac{d}{M} \frac{O}{G} + \left(\frac{S}{2} \right) \right\} \frac{1}{K}}{1 + \frac{S}{2}}$$

Where
S = The shrinkage expressed as a fraction of the dry gas volume.

This equation can be solved for the oil to gas ratio to obtain:

$$\frac{O}{G} = \frac{AK \left\{ 1 + \left(\frac{S}{2} \right) \right\} - \frac{S}{2}}{3.16 \frac{d}{M}}$$

Substituting the data used previously and in addition a value of S = o.2, there is obtained:

$$\frac{O}{G} = 117.7\ K - 6.5$$

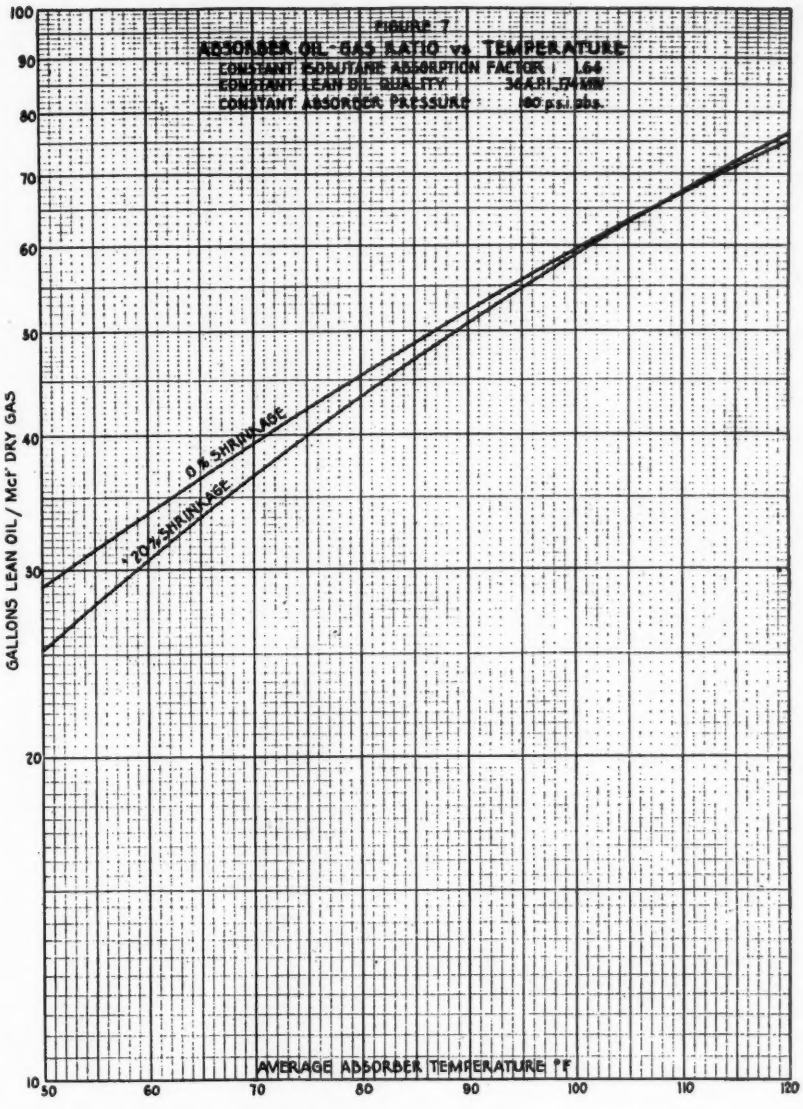
The lean oil to dry gas ratio computed from this equation is also plotted on Figure 7 and can be compared with the ratio computed by neglecting the shrinkage. Note that at a lean oil to dry gas ratio of 65.2 the two curves give the same result; that is, the finite shrinkage does not affect the oil to gas ratio required. If you will check the data you

will find that at this ratio the molal ratio is equal to one and constant throughout the absorber. As the ratio decreases or increases the shrinkage effect becomes more pronounced.

To use the above curve the operator must determine the average tower temperature. Having determined this temperature the proper ratio can be selected. It is assumed, of course, that the shrinkage is sufficiently constant so that changes in its effect are negligible.

As mentioned previously, the plant outlets should be checked occasionally to directly determine the percentage extraction. That is, the absorption factors computed as above should be empirically correlated with plant performance. By using absorption factors in this manner any errors that may be involved in the simplifying assumptions made in arriving at the factor will be compensated for to a large extent. That is the absorption factor is used as means of properly combining all the operating variables to arrive at an entity that can be correlated with extraction performance. Such a correlation can take the graphical form of a curve showing plant isobutane extractions for various absorption factors. If two stages of absorption are used a series of curves, with one absorption factor as the parameter and the other as the abscissa, will properly handle the data. Note that a direct correlation of this type neatly sidesteps the question of the number of equilibrium plates in the absorbers.

To arrive at the percentage plant extraction we recommend measuring, sampling, and analyzing all the plant outlets. By converting each constituent of the gasoline to its equivalent standard gas volume, the plant outlets may be added together in the proper proportion to obtain the volume and analysis of the wet gas. Having these, the percentage extraction and percentage losses at each point may be readily ascertained. This method of obtaining the wet gas analysis and volume circumvents the almost insurmountable difficulties encountered in the metering and sampling of very rich gases. The difficulties arise from the tendency of these rich gases to deposit condensate in the lines even after they have been passed through a scrubber. In addition, the wet gas streams to the absorbers often contain one or more plant recycle streams which of necessity would have to be subtracted from an analysis of these streams to obtain the net wet gas to the plant. By analyzing the outlets on samples obtained over a twenty-four hour period, and by holding any accumulation within the system to a minimum, you can be reasonably assured of obtaining a representative analysis of the net wet gas to the plant by adding up the outlets in their proper proportion.



Summary

The derivation of the absorption factor has been briefly reviewed to illustrate the significance of the absorption factor. It has been shown that the absorption factor properly combines the operating variables into an entity which can be correlated with plant performance. In addition several methods for controlling absorbers in the plant were outlined.

Erwin, Wasey & Co. Organizes Industrial Dept.

Recognizing the growing importance of the Pacific Coast as an industrial empire, Erwin, Wasey & Company has organized an Industrial Department to serve clients in its Los Angeles, San Francisco and Seattle offices. This department will be headed by Roy F. Irvin who has specialized in industrial advertising for many years. Irvin will make his headquarters in Los Angeles. Erwin-Wasey now directs the advertising of Chiksan Tool Co.; Summerbell Roof Structures; Water Cooler and Space Heater Divisions of the Day & Night Manufacturing Co.; Export Department of Security Engineering Co.; Plumbing Division of Nigg Engineering Co.; Refrigeration Engineering Co.; Warman Steel Casting Co.; Cannon & Maclean, lubrication engineers.

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The "Hodag" will have a birthday cake and candles after the rest of the unconditional surrenders are won. Right now we are too busy to celebrate. Actually, we are hedping PRE FORM Victory with the greatest production we have ever achieved.

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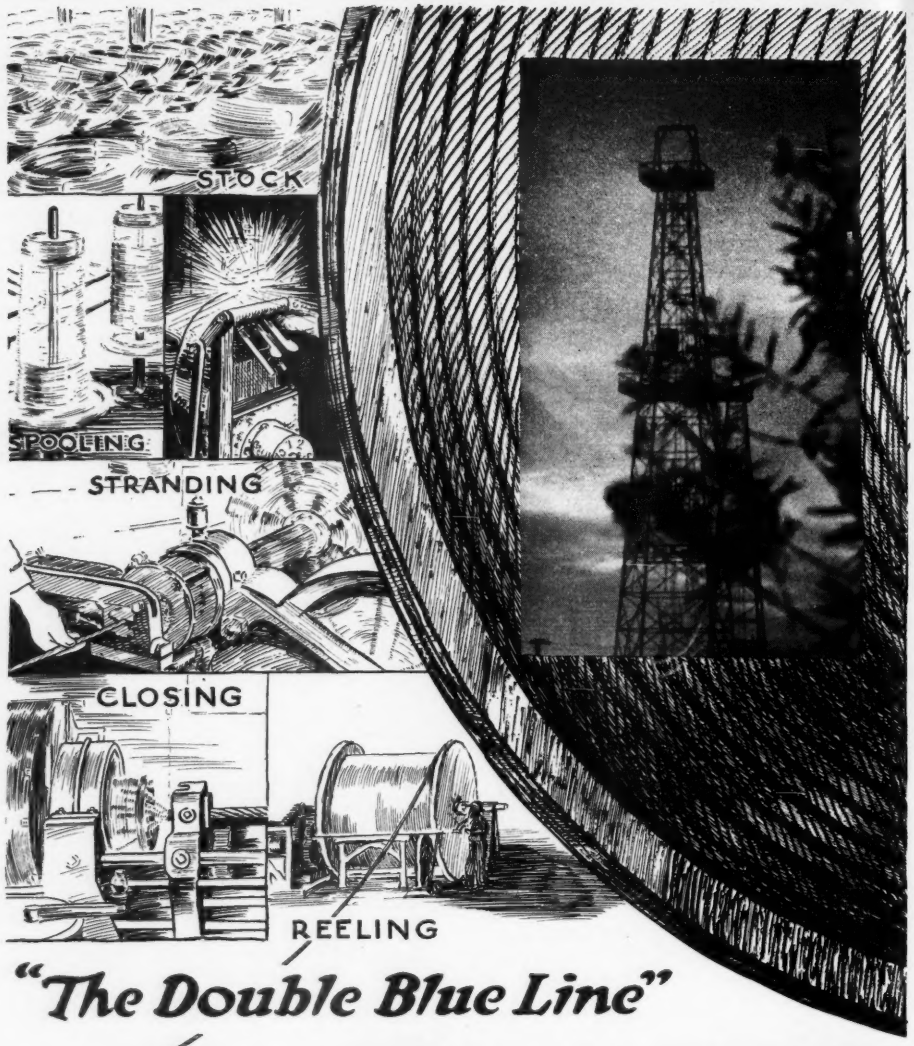

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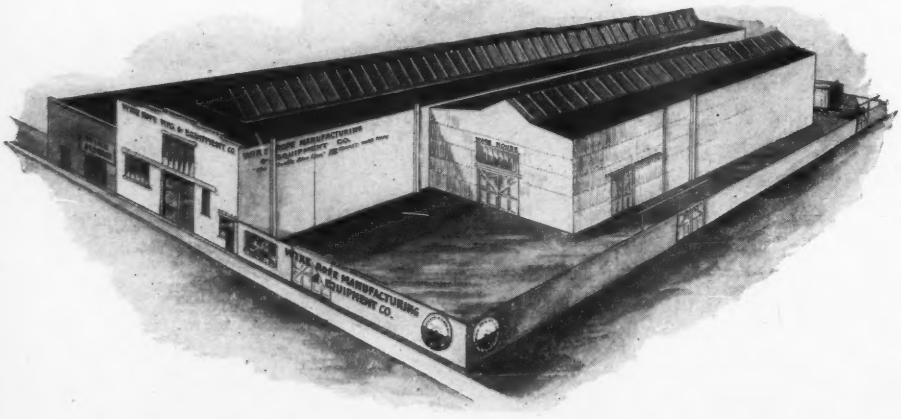

Distributors:

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Maintenance Program For Compressor Plant Operators

By L. F. Scheel,
Union Oil Co. of California

The air or gas compressor has had a minor application in an oil refinery. It was used for operating pneumatic tools, controls, air blown asphalt stills and perhaps a refrigeration or Edeleanu plant. This was prior to the demand for large quantities of high octane fuel from the various new catalytic cracking processes. The modern refinery is now equipped with several thousand horsepower of compressors. The maintenance of such large plants is new to the refiner and has undoubtedly presented problems of a different order than those to which he has been accustomed.

We, in the natural gasoline industry, have nurtured the heavy-duty gas-engine driven compressor for a score of years. Perhaps we have encountered problems that you refiners have met or may meet.

Fuel Supply

The natural gas supplied by the public utilities is the best fuel source. A constant quality of dry clean gas is desirable with the propane and heavier fractions limited to 13 per cent or 1,300 Btu (gross) per cubic foot. It has been with reluctance that occasionally we have had to use stabilizer waste gas blended with the dry engine fuel. This practice usually results in "rough" operation or engine detonation and may eventually influence the piston and bearing repair.

A constant fuel pressure is necessary to insure a uniform mixture over the full operating range. The purpose of the four cycle engine's sensitive fuel regulator, or a gasometer, is to maintain a constant pressure of one inch of water. Pressure variations in the eight-ounce fuel header will make this operation less responsive. For this reason, it is preferable to use one large pilot operated reducing regulator rather than small individual less active regulators.

Year in and year out fuel consumption will average 10.5 cu. ft. per brake horsepower hour of 1130 Btu (gross) per cu. ft. gas at 100 per cent load factor; 11.8 cu. ft. at 80 per cent load; 14 cu. ft. at 60 per cent load. The fuel rate will hold for both four-cycle and two-cycle injection engines. Under test conditions we have always met the manufacturers usual guarantee of 10,000 Btu (net) per brake horsepower hour.

Ignition System

A low tension magneto, with a rotating field and the high tension coil at each spark plug, is the ultimate for ignition purposes. This type minimizes the corona loss that exists in transmitting the high tension spark 12 feet on the modern angle type unit. It also prolongs spark plug life. The next best selection is the rotating high tension magneto. The oscillating type magneto is passe. Positive timing over long periods was impossible because of wear of the trip finger.

The desirable type of spark plug has a "cold body", a heavy center electrode and multiple body electrodes. The greater electrode surface gives longer firing life. A good operator will set the electrode clearance at about .012 inch. In the course of six to eight weeks, a heavily loaded two-cycle engine will burn the electrodes as much as .040 inch. A four-cycle, vertical engine will burn the electrodes about .015 inch in the same period, while the old horizontal engine will burn less than half of this amount. It is good practice to adjust the spark plugs at least once a month to insure steady operation and protect the magneto condenser and windings.

Lubrication

The mechanical maintenance of the compressor is so strongly influenced by the quality of the lubricant that you can ill afford to be critical of the price.

Lubrication engineers formerly recommended two and sometimes three grades of oil for a gas engine driven compressor; one for the bearing circulation, a second for power cylinders, and a third for the compressor cylinders. We have found that one grade, generally SAE 30, is sufficient. When the vapors are especially wet, it is advisable to use a compounded oil for the compressor cylinders. A carbon residue of .06 per cent or less and a viscosity index of 80 per cent or better, are the important specifications.

The problem of changing the crank case oil has been solved for many operators by filling the mechanical lubricators from the crank case circulation system. All make-up oil is added to the crank case; this will replenish the crank case contents every few weeks. Some of the new engines are factory equippd with this feature.

The oil consumption will depend upon the type, mechanical condition of the engine and the care exercised by the attendant. Each compressor cylinder will require about one quart per day, and the metallic piston rod packer about one pint per day. Each hundred horsepower, four-cycle cylinder will require two quarts per day; a two-cycle cylinder will require three to four quarts per day. These rates are based on filling the lubricator from the crank case. It will include the crank case loss and normal wastage. Expressed in terms of horsepower hours per gallon of overall lubrication: the four-cycle unit will run between 2000 and 3000; the two-cycle unit will average 1500 to 2000, and the old style, four-cycle, double acting unit will only average 1000 to 1500.

The problem of oil filters is highly controversial, because it is difficult to prove the superiority of one system over another. A few plants have operated years without an oil filter. This is poor practice. There is a wide selection of filters ranging from cheap muslin bags, cotton waste packs, patented chemical packs, etc., to the elaborate washing and centrifuge equipment. If the value of the oil can be considered on a manufacturing cost rather than a selling price, it is difficult to justify any system more expensive than the cotton waste pack. This is especially true if the lubricators are filled from the crank case.

With some engines you can combine the oil circulation from the individual engines into a common overhead reservoir. The oil can be filtered in a single unit and dispensed to the various points without the hazard of an individual oil pump failure.

One of the most successful improvements on the vertical gas engines in recent years has been the oil cooled piston. It has greatly reduced the sticking of piston rings, especially on two-cycle engines. This cooling oil will pick up about 500 Btu per horsepower hour and must be cooled. It is advisable to cool the crank case oil in any engine where the operating temperature exceeds 150 deg. F. Oil above this temperature tends to oxidize, to become acidic or corrosive, and to form a shellac. While on the other hand, oil at temperatures below 100 deg. F. will lose the desirable fluidity and have a tendency to pick up condensate and emulsify. The desirable operating temperature of crank case oil is between 120 deg. and 140 deg. F.

Jacket Water

The key to smooth engine performance is to keep the piston and cylinder heads at a temperature below which fuel detonation occurs. This is controlled by the quantity and in certain instances, the

outlet temperature of the circulated jacket water.

The jacket water in the old style horizontal gas engine would absorb about 27 per cent of the heat input at full load. A water circulation of 30 gallons per brake horsepower hour would give a 13 deg. F. temperature rise through the power cylinder and another 1 deg. F. through the compressor cylinder. In order to obtain smooth performance and maximum output of a two-cycle horizontal engine it was necessary to limit the temperature rise to 8 deg. F. and outlet temperature to 110 deg. F. The usual engine outlet temperature was about 125 deg. F.

The manufacturers of the new vertical or angle powered units recommend a jacket water circulation of 50 gallons per brake horsepower hour. As previously related, the oil cooled piston absorbs about 500 Btu per brake horsepower hours, a like amount for the compressor cylinder and about 4000 Btu per brake horsepower hour or one-third of the heat input will be absorbed in the newly designed cylinder jackets and exhaust manifolds. The jacket water will pick up 12 deg. F. at the above circulation. An outlet temperature 160 deg. F. is generally satisfactory. The higher outlet temperatures have resulted in reduced cylinder wear.

The early proceedings of the C.N.G.A. will reveal that there was a time when economy of a closed jacket water system was questioned. There are several hundred cracked cylinders and heads that will testify that the open jacket water system is taboo. The soft water used in a closed system should carry an inhibitor to prevent the corrosion of the iron. We have found that a sodium dichromate concentration of two pounds per thousand gallons to be an excellent inhibitor.

Two other essential features of a jacket water system that should be included are: vent the jacket water system at the high point on the power cylinder or head; and minimize the back pressure on the power cylinder jacket. The jackets should be the last resistance in the jacket water circuit.

We have found that it requires four barrels of jacket water make-up per horsepower month. Allow six barrels per horsepower month for your cooling tower make-up to cool the jacket water coils, the same quantity for make-up to cool the gas coils and for "wet-exhaust" cooling. The auxiliary equipment to circulate the jacket and tower water generally requires 5 per cent of the total plant power.

Air Cleaners

The air cleaner is a desirable protection against abrasive material that may be carried in the air during dust storms, etc. We carefully micrometered the cylinder wear of power cylinders for four years that were alternately protected with air cleaners. We were not able to detect any difference in the wear. This test was conducted at Santa Fe Springs and there were no dust storms of consequence during this period. In another instance, we encountered excessive wear in several air compressor cylinders and rings, operating adjacent to a construction job, where considerable dust and cement were carried with the air. The oil bath type air cleaner is very satisfactory. The dry type has not been effective in trapping fine dust particles. The cloth bag type requires more maintenance and one must accept the hazard of holes developing in the cloth bag. The oil bath type air cleaner is also an effective intake silencer, making it possible to install an interior air intake.

Exhaust Mufflers

The exhaust muffler that induces a secondary air flow around the exhaust line has proven to be an effective silencer and means of cooling the exhaust lines.

Alarms

Automatic signals and shut-down devices have proven their worth in supplementing the operating personnel. The greatest hazard in a compressor plant is the danger of carrying liquid into the compressor cylinders. This will rupture the cylinder and generally result in a fire. We always provide generous sized intake scrubbers with automatic and emergency manual drains. Should the liquid level rise above one-third of the scrubber capacity a Mercoid float activated alarm is sounded, and a red light will indicate the vessel is in danger. If the level rises above the midposition, an automatic magneto grounding device will shut down the plant. Similar alarms and red lights are often used to call the operator's attention to such important changes as:

a. Low jacket water pressure.
b. Low oil reservoir level.
c. Abnormal pressures on compressor manifolds.

Every engine is equipped with an automatic overspeed, shut-down device to insure against a flywheel explosion, etc., in case of a governor failure. This device should be tested at least every six months, or you may find to your sorrow that it was not in working condition. Most engines are equipped with a low oil pressure shut-down device. Some of the new engines are provided with high jacket-water temperature shut-down devices. These devices are good insurance.

Mechanical Maintenance

Dependability is the first requisite for the prime mover in a compressor plant. A vigilant mechanical maintenance program is the means to this end. We attempt to maintain the equipment in "new engine" condition by means of regular overhaul schedule. This will forestall most involuntary shut-downs and minimize extensive repairs. The frequency of the overhaul is predicated upon the load factor, type of equipment and the experience of the supervising mechanic. A heavier loaded unit may require an overhaul as often as every eight months. A lightly loaded, low-speed engine may only require an overhaul every four years. The modern angle type unit should be overhauled every 12 to 18 months. This overhaul would include:

a. Freeing the piston rings.
b. Removing the coke from the grooves, piston body, and exhaust ports.
c. Change or reface (when necessary) the exhaust (or injector) valves, guides and seats.
d. Check the main and rod bearings.
e. Clean the jackets and crank case.
f. Change the oil filter (every four to six months).
g. Check wedge bolts, tie rods and yokes.
h. Clean the intake (or air) valves, governor or fuel mixer.
i. Micrometer and record the cylinder wear.

The last item is an important gauge on the effectiveness of your maintenance program. The cylinder wear of .003 inch per year is normal for a well operated plant. After a few years of operation you may not detect any change in the cylinder wear. Some mechanics maintain that a "work-hardened" or glazed cylinder will not show perceptible wear unless you encounter abnormal operating conditions. A cylinder may wear uniformly as much as .070 inch without serious loss of power. A horizontal cylinder will generally wear "out of round" or "egg shaped". Then half of this wear will impair the piston ring action and reduce the power capacity. The average cylinder should operate for about eight years before reboring. We have run many cylinders more than twice this period. We have one plant equipped with honed cylinder whose wear record indicates that they will outlast any cylinders heretofore used. We generally rebore the cylinder to ⅛ or 3/16 of an inch oversize. We have rebored some cylinders a second time, finishing the cylinder at ¼ inch oversize. The manufacturers have set ¼ inch as the limit.

The crank bearings should have a life of three to four years. The main bearings should serve for five years or better. With a good job of babbitting and a machined fit, the bearing life will be largely

(Continued on Page 34)

Cycling Operations and Potential Use of Products

By
James E. Pew, Director
Natural Gas and Natural Gasoline Division
Petroleum Administration for War

I have chosen "Cycling Operations and Potential Use of Products" as my subject in order that I might emphasize the major role that those operations are today playing in wartime production and will continue to play upon the return of peace. The coming months will see the Paloma Cycling Plant, in which some of you are personally interested, placed on stream, adding 7500 barrels per day to the nation's supply of those light hydrocarbon fractions which are volumetrically equivalent by virtue of their natural highly refined state, to two or more times their production in terms of crude oil. It is wise, then to review the state of the industry—to consider briefly the past, but more fully the present and future scope of cycling operations.

It is interesting to note that two Californians, Bruce H. Sage and William N. Lacey, have played an active role in the amassing of knowledge pertinent to this offshoot of the natural gasoline industry. At the request of the American Petroleum Institute, they early undertook a comprehensive study of the complex phenomena associated with retrograde condensation in the reservoir. That investigation, as you know, culminated with issuance of an authoritative text, **Volumetric and Phase Behavior of Hydrocarbons.**

The authors have continued their research, however, on the nation's condensate wealth, which today lies essentially in the Southwest. In the last decade, condensate field discoveries in that area have risen yearly, reaching a peak of 44% of the total number during the first half of this year. But there are no strict geographic—only geologic—limitations: such fields have been found in the North, in the Turner Valley field of Canada; in the East, in the Oriskany fields of the Appalachian Area; in the Rocky Mountain region, where construction of a cycling plant for the Walden area, embracing the North and South McCallum anticlines of Jackson County, Colorado, is now under consideration; and on the Pacific Coast, at Kettleman Hills, Paloma, South Coles Levee and Helm. Condensate reserves do not appear large in the petroleum wealth of the United States, representing only about 5% of the total, but they assume Herculean stature through their potential use.

The first plant for cycling gas—condensate production was placed in operation early in 1937 in the Agua Dulce area of South Texas, following what might be termed "pilot plant" operations at the Big Lake field in Texas. Unitization was then slowly building a case for itself, but unit operation for the field was not undertaken. Today four plants are operating at Agua Dulce, but they, through coordination of effort, are effectively removing the increasingly valuable lighter hydrocarbons from the condensate sands. And it is from Agua Dulce and Stratton, both appearing to be major producing problems upon their discovery, that gas, having served its purpose of expelling liquefiables from the reservoir, will be sent to the Appalachian area this coming year and thereafter through a gas-bearing "Big Inch".

In the ensuing six years, cycling plants have passed through stages suggested by the natural gasoline industry—simple separation, stage separation, refrigeration and stage separation—until today the absorption type plant, capable of operating at pressures up to 2,000 pounds, is in use almost exclusively. Modern cycling plant design has permitted conversion, easily, to embrace technologic advancements as they were made.

With present-day design, cycling plants can function either in complete or partial coordination with refinery operations. When cycling operations are completely coordinated with those at the refinery, the wet gas is processed initially to effect removal of all liquefiables, with extraction efficiencies running as high as 85% on butanes, and 99% on the heavier hydrocarbons. The fractions so recovered are then separated into (1) and ethane-propane mixture which in the absence of a market may be injected into the producing formation in liquid form; (2) a mixed butane fraction, which is carried to the refinery by pipe line; (3) a fraction containing pentanes plus, which is delivered to the refinery by pipe line or truck; and (4) a residual oil, suitable for use as plant absorption oil.

It is a plant of the type just described which is currently under construction at the Paloma Field, Kern County, California, with delivery of products scheduled to the new 100-octane plant of The Texas Co. refinery. It should be noted, however, that this is by no means an inflexible arrangement Modern cycling plant design readily permits of partial dissociation with the refinery. Through extensions of minor magnitude, plants can be altered for semi-independent operation.

Partially integrated operations are now in common use. In the course of such operations, the ethane-propane mixture may be returned to the formation and the butane fraction transported to the refinery by pipe line, as before. The heavier products, however, are processed to yield a finished grade of fuel—either motor fuel, or 87 or 91 octane aviation fuel—while the naphtha (separated when aviation fuel is produced), kerosene, and absorption oil are separated and retained or marketed. Only a minor change in plant operation is required to yield motor fuel or high octane fuels, as desired, again illustrating the extreme flexibility of cycling plant operations. The naphtha yield in the production of high-octane fuels has been found to have a market as charging stock for use in the thermal cracking "quick butadiene" process. Plants in the Agua Dulce-Stratton Area of South Texas may be cited as typical of those operating in partial coordination with refineries.

In a modification of this type of operation, the cycling plant may again return the ethane-propane mixture to the producing formation and separate the butane fraction into normal butane and isobutane. The normal butane is then distributable by tank truck in the form of

a liquefied petroleum gas, or as a chemical raw material while the isobutane is delivered to the refinery for alkylation. The heavier fraction is then made to yield motor or 87 or 91 octane fuel, as desired. The disposition of the naphtha, kerosene, and absorption oil produced has earlier been noted. It is evident, then, that the modern cycling plant can be of major importance in today's wartime production, while it is further evident that minor changes in post-war plant operation will make available a steady flow of valuable peacetime products.

The hastening of Allied military operations, with the extension of major operations to two main theaters of war, Euporean and Pacific, has of necessity been accompanied by heightened demands for aviation fuels. Deputy Petroleum Administrator Ralph K. Davies stated on October 21st that production of these high octane fuels has increased over 400% since the outbreak of war. The lighter hydrocarbons obtainable through cycling have played a highly signficant part in making possible that increase.

Cycling operations are fundamental to the success of the aviation fuel program as they make available a substantial portion of the isobutane which goes into the production of iso-octane alkylate; isopentane; and base stocks. It is accordingly altogether possible to produce a finished 100-octane aviation fuel from raw material derivations of the cycling plant.

But what of the economic considerations involved in cycling operations? Because of your distance from the center of these operations —P. A. W. District III—you men of the California natural gasoline industry are probably not overly familiar with such considerations. It may be well to digress momentarily, then, to look at condensate field development as expressed in terms of dollars and cents.

Unitization of condensate fields, which permits of a characteristically conservative development, is capable of yielding returns equally as profitable as those obtained in the closely-spaced competitive development of oil fields. Unitization has long been a stumbling-block in the path of oil and gas conservation, and nowhere more so than in California. Last month Mr. E. E. Pyles, Chairman of District V's Petroleum Industry Production Committee, speaking on "Sources of California's Future Oil Supplies" before the Interstate Oil Compact Commission, stated:

> "The principal problem in California . . . is not the technique of recovery but rather the problem of educating our producers and land-owners to the desirability of such a procedure and the necessity of unitized or ccoperative work as a prerequisite to successful recovery methods. Oil production in this State for the past twenty-five years has been on a highly competitive basis with most of our fields highly diversified in their surface ownership . . . Unless, and until our operators are fully conversant with the problem and are willing to throw into the pot their individual properties for the greater reward of increased recovery, little can be accomplished of a substantial nature."

The natural gasoline operator, living on the waste product of the oil operator, has in the past unkindly but perhaps realistically been termed a scavenger. I believe that his physiognomy is today altering in the eyes of the oil industry, and that he no longer appears a hungry vulture, but rather a wise old owl. He has played a prime role in making the oil industry conservation-conscious, and today that industry is learning another lesson from him through the efficacy of his unitized cycling operations, doubly necessary in condensate development.

In wartime condensate has assumed, through its natural highly refined state, a value superior in many instances to that of crude oil. In this connection, data compiled by the Subcommittee on Aviation Gasoline Potentialities established by P. A. W. District III's Natural Gas and Natural Gasoline Committee are of interest. It was disclosed that aviation grade naphtha could be made available through cycling operations for only 28% of the critical material expenditure required for well-head production of this valuable fraction in crude oil. Following the extensive study undertaken, the Subcommittee issued three recommendations which indicate fully the potentialities of cycling plant operations. These were:

1. Development of condensate fields for cycling plant operations, including installation of equipment for segregation of components necessary to the aviation fuel program.

2. Increased recovery and segregation of aviation fuel materials through installation of additional facilities in plants now operating.

3. Utilization of components such as ethane-propane mixtures, now being produced but not entering into the war program, for increased production of super aviation fuel.

Some conception of the saving in both critical material and capital in the production of lighter hydrocarbons from condensate fields may be afforded by reference to the recently prepared program determination of the Natural Gas and Natural Gasoline Division of the Petroleum Administration for War, which calls for construction capable of yielding an additional 35,000 barrels per day of condensate, natural gasoline and lighter hydrocarbons. The estimated capital investment is $28,800,000, of which $10,800,000 covers the cost of the wells. The expenditure in critical material is estimated at 58,350 tons, of which 28,350 tons will be utilized in these well completions.

The completion alone of crude oil wells for production of an equivalent volume of similar hydrocarbons would total $55,800,000, while production of an equivalent volume of crude alone would cost $31,500,000. In terms of critical material, expenditures of 216,000 tons and 105,120 tons respectively, would be involved. In terms of processed production and reinjection in condensate fields versus well-head production in oil fields, the latter would cost nearly twice as much, in terms of capital investment, and nearly four times as much in terms of critical materials.

Returning to the consideration of cycling plant products, I should like to separate them into four major groups, examining them more or less in the order of their availability for utilization. Such a grouping affords:

1. Motor fuels and condensates
2. Butane and pentane fractions
3. Ethane-propane mixtures
4. Dry gas

In the past, base motor fuel and condensate stocks have not appealed too highly to refiners, because of their relatively low volatility and anti-knock rating. These factors, al-

though offset to some extent by a high susceptibility to loading, have prompted refiners to reform base fuels from cycling operations into higher octane fuels. On the basis of cost, however, the refiner cannot compete with the cycling plant operator, and satisfactory motor fuels, including leaded grades, can be produced in the field for less than 2½c per gallon. With declining crude discoveries and increasing condensate discoveries now the order of the day, increased use of cycling plant fuels may be looked for in the future. The cycling plant operator, can readily adapt his operations, at slight cost, to embrace the major technologic advancements of today and tomorrow.

In processing the butane and pentane fractions separately, isomerization, polymerization, hydrogenation, dehydrogenation, and alkylation methods are employed. However, in the production of super fuels and products, no process may be looked upon as being of static design: new methods must be constantly explored with a view toward making more efficient use of these lower-boiling fractions, which promise to be of even greater value in the post-war period. Their potentialities mark them as being among the most valuable of the hydrocarbon fractions.

The large quantities of liquid ethane-propane mixtures presently separated in cycling operations, but returned to the producing horizon in the absence of a market, will find that market with improvement of transportation, storage techniques and chemical development. They bear consideration, in such event, as industrial liquefied petroleum gases. Several other possibilities suggest themselves: first, that they are potentially useful as manufactured gas enrichment agents, and, second, that inasmuch as it has been proved possible to produce carbon black from liquid hydrocarbons, and since higher yields have been noted with higher ethane content of fuels used, they would appear to be of potential importance in the production of this necessary item, in which 11% of the nation's total gas consumption was utilized this past year.

Again, with the development of modern methods of regenerative cracking, cycling products are available for the production of such chemical raw materials as acetylene, ethylene, propylene, butadiene, and benzene. Generally speaking, today's super war products are synthesised from chemically active unsaturated hydrocarbons such as these, either produced or producible with cycling products as basic constituents. Ethylene and propylene so obtained afford unsaturates of prime value in the production of neohexane and cumene. In combination with benzene, ethylene may also yield styrene, a principal component of Buna S rubber. By rearrangement or recombination, hydrocarbons obtainable in the cycling plant can provide the raw materials for any of the five basic types of synthetic rubber, from which airplane and other tires, innerseal semi-solids for gasoline tanks and tubes, and other products of diversified nature may be derived.

When all liquefiable hydrocarbons have been removed from the condensate reservoir, 85-90% of the original gas content will still be contained therein if maximum production has been obtained through reinjection of residue gas. This dry gas, having performed its initial task of expelling liquefiables from the reservoir, is then available for use as fuel, for gas lift or repressuring in another field or another horizon or for conversion into useful products.

Rapid developments in petroleum chemistry, particularly since 1930, have shown that natural gas will react when activated by the effects of heat, pressure, chemical reagents, and light; and that these reactions can be made to proceed at practicable conditions, especially if catalysts are employed. As these results became known, the possibility of a synthetic organic chemical industry based upon these reactions became apparent, and today this industry is large and growing rapidly. It would require a volume to set forth all the potential uses of natural gas and that volume would be obsolescent prior to completion. As Dr. Gustav Egloff, our foremost hydrocarbon protogenist, has so ably said:

". . . if we start with methane gas alone, all of the known synthetic products that man has produced in organic chemistry can be derived. Any synthetic product can be produced at a price; the hydrocarbons are all potentially available to be converted into the manifold products that man requires in a modern world."

Thus the natural gas being reinjected and stored for future use becomes of increased value with each technologic advance. As an example, today in wartime, synthetic ammonia continues to find itself an important base material in the production of munitions. In the production of synthetic ammonia the most difficult and expensive ingredient to obtain is hydrogen. Today approximately 50% of the emergency synthetic ammonia is manufactured with hydrogen derived from natural gas with a great saving in investment, time and critical materials.

One of the outstanding potential uses of dry natural gas is the synthesis of liquid hydrocarbon fractions by means of a process commonly referred to as the Fischer-Tropsch process. The production of motor fuel by means of this process, in this event making use of a solid fuel (coal or coke) is now in commercial use in Germany. It is interesting to note that an estimated 50% of Western Axis oil is obtained through synthesis, and that the aviation fuel derivative reportedly will bear favorable comparison with our high octane products. With natural gas as the raw material, three steps are involved: reforming to water gas (hydrogen and carbon monoxide), synthesis into liquid hydrocarbon fractions, and finally recovery and separation. The three steps are already being practiced separately on a commercial scale, and in all likelihood a combination commercial installation will be realized in the near future. Gasoline, fuel oil, and heavy oil will thereby be made available under favorable economic conditions to augment our declining petroleum resources.

Oxygen is today being introduced into the hydrocarbon molecule on a commercial scale, but the mixture of products so obtained makes recovery and separation difficult. A process should be available in the near future, however, whereby natural gas may be converted into formaldehyde, with a high degree of purity. Through this process, natural gas will become available to the expanding plastics industry in the form of this basic raw material.

Of the total current 260,000 barrels daily of natural gasoline and cycling plant products, it is estimated that one-fourth is produced in cycling operations. Plants now being constructed—among them the Paloma Plant—will materially add to the present cycling plant production, while additional construction programmed by the Natural Gas and Natural Gasoline Division of the Pe-

troleum Administration for War for completion by the end of next year will result in cycling plant production approaching 40% of the total production of natural gasoline and allied products. Such operations are, then, obviously destined to play an ever-increasing part in the recovery and utilization of the lighter hydrocarbon fractions, both in the war and post-war periods.

It is not possible to prophesy the extent of the role which cycling operations will play in future development in California; but it is possible that deeper drilling will result in the discovery of additional condensate pools. But whatever the importance of the role that cycling operations may assume here, I am sure that you men of the natural gasoline industry will fill that role capably.

Maintenance Program For Compressor Plant Operators

(Continued from page 30)

determined by the care received from the operator.

A plain cast iron exhaust valve and seat should average about six months service in a heavy gas engine. A chromium alloy valve and seat with a well guided and lubricated stem should increase the life considerably.

A mechanical maintenance program of this order will require one mechanic for every eight-hundred horsepower. The ratio will run as high as 1200 horsepower per mechanic for the modern units and as low as 600 horsepower for old horizontal, double acting, tandem equipment. This may appear to be a rather high ratio, but it represents a sixteen year average for seven plants, ranging in size from 600 to 5400 horsepower. It includes the maintenance of all auxiliary equipment, the water and gas coils, etc. This does not mean that for every 800 horsepower, you might expect to have a mechanic work every fourth day on every 200 horsepower engine. Quite to the contrary, our records show that we have only 0.5 per cent "down time" for repairs. This means that, on an average, every engine is down for repairs, overhaul or check, one eight-hour day every two months. When an engine is down for overhaul or repair, it is generally advisable to use a crew of about six men in order to minimize the time out of service. 90 per cent of this "down time" will be of a voluntary nature. Brief shut-downs of less than 15 minutes duration are not included in this figure.

The modern gas engine driven compressor is the result of keen competition and ingenious design. It is our responsibility to obtain maximum performance from this equipment. We have a job to do!

GROUP OF SPEAKERS, EIGHTEENTH ANNUAL MEETING CALIFORNIA NATURAL GASOLINE ASSOCIATION, BILTMORE HOTEL, LOS ANGELES, NOVEMBER 5, 1943: Left to right: C. D. Gard, Union Oil ompany, chairman morning session; Randal Maass, General Petroleum Corp.; Lyman Scheel, Union Oil Company; James E. Pew, Director, Natural Gas and Natural Gasoline Division, Petroleum Administration for War; R. W. Heath, Signal Oil & Gas Co., president, C.N.G.A.; E. G. Ragatz, Bechtel-McCone-Parsons Corp.; P. S. Magruder, General Petroleum Corp., chairman, afternoon session; Dr. A. H. Boultbee, Shell Oil Co., Inc.

The Use of Natural Gas Components in Refinery Operations

(Continued from page 21)

stock for isomerization plants whereby it will be converted to isopentane.

Fraction Distilling Above 122°F.: Used as aviation base stock with or without rejection of normal hexane concentrate and rejection of high boiling ends to motor gasoline. This base stock together with straight run base stock is blended with other high octane components, e. g. isopentane, alkylates, etc. to produce finished aviation gasoline. These base stocks are frequently of the order of 50 per cent of the finished aviation gasoline.

Fraction Distilling in the Tolune Range (231.3° F.): As feed stock for natural and synthetic toluene plants, the toluene being used for manufacture of T. N. T. or alternatively, used as a desirable blending agent for aviation gasoline.

It is apparent from the foregoing that natural gasoline components are playing a major role in the production of materials required for the successful prosecution of the war and can become an important raw material in the postwar synthetic organic chemical industry.

California Oil World is indebted to the California Natural Gasoline Association for the privilege of presenting to our readers the following papers which were delivered at the Fall Meeting of the Association, held at the Biltmore Hotel, on November 5th.

"Cycling Operations and Potential Use of Products" by James E. Pew, Director of Natural Gas and Natural Gasoline Division, Petroleum Administration for War.

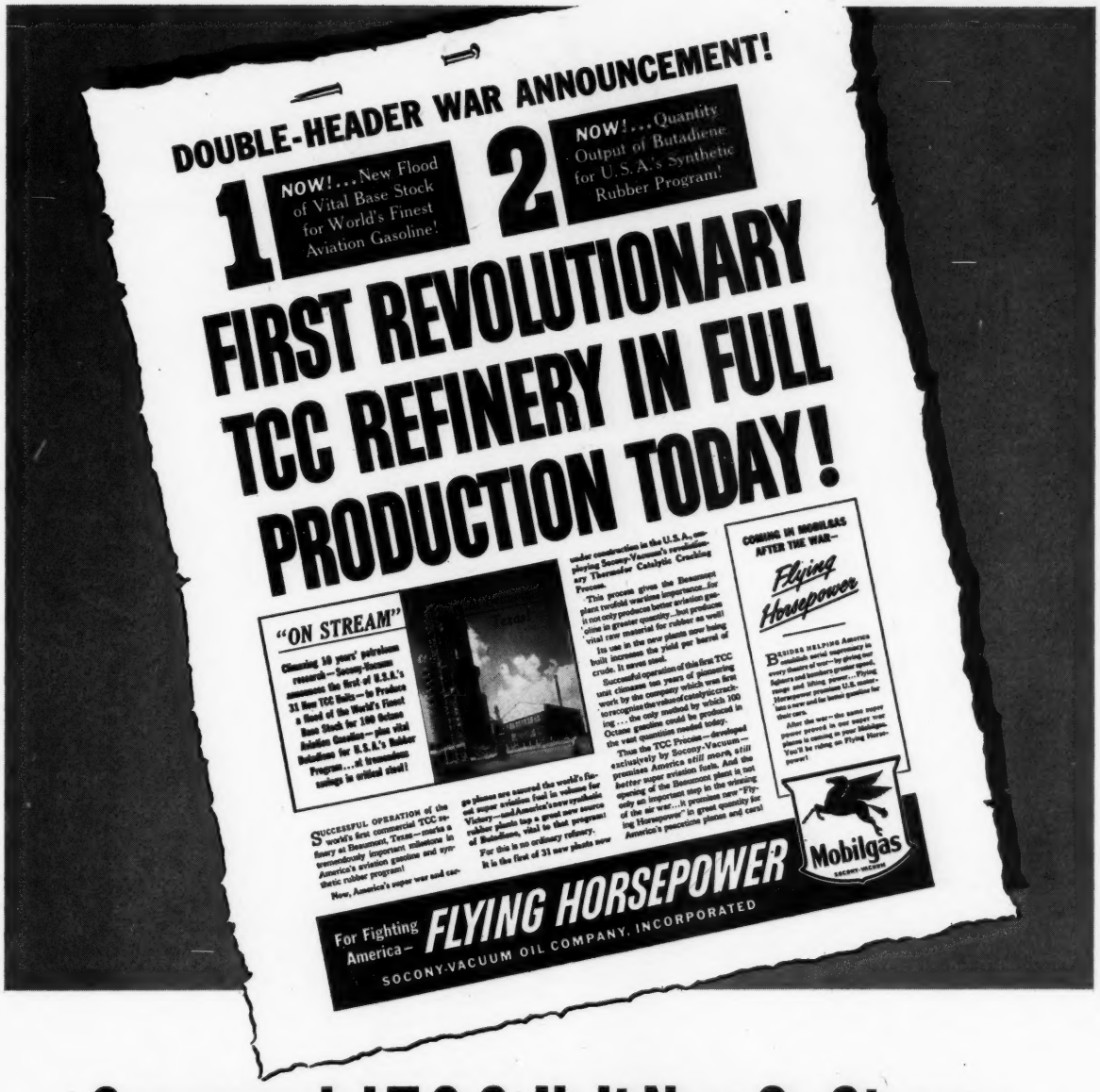
"The Use of Natural Gas Components in Refinery Operations", by A. H. Boultbee of Shell Oil Co., Inc.

"The Absorption Factors in Controlling the Absorption Process", by Randall Maass, General Petroleum Corp. of California.

"Maintenance Program for Compressor Plant Operators", by L. F. Scheel, Union Oil Co. of Calif.

"Refinery Processes for War Products", by F. D. Parker & E. G. Ragatz, Bechtel-Mc-Cone-Parsons Corp.

C.N.G.A. meets regularly the first Thursday of each month at Rio Hondo Golf Club, 607 North Old River School Road, Downey. Dinner at 6 P.M., meeting at 7:30 P.M. Meetings open to all those interested.


DOUBLE-HEADER WAR ANNOUNCEMENT!
1
NOW!...New Flood of Vital Base Stock for World's Finest Aviation Gasoline!
2
NOW!...Quantity Output of Butadiene for U.S.A.'s Synthetic Rubber Program!
FIRST REVOLUTIONARY TCC REFINERY IN FULL PRODUCTION TODAY!
"ON STREAM"
Climaxing 10 years' petroleum research—Socony-Vacuum announces the first of U.S.A.'s 31 New TCC Units—to Produce a Flood of the World's Finest Base Stock for 100 Octane Aviation Gasoline—plus vital Butadiene for U.S.A.'s Rubber Program...at tremendous savings in critical steel!
SUCCESSFUL OPERATION of the world's first commercial TCC refinery at Beaumont, Texas—marks a tremendously important milestone in America's aviation gasoline and synthetic rubber programs!
Now, America's super war and can-so planes are assured the world's finest super aviation fuel in volume for Victory—and America's new synthetic rubber plants top a great new source of Butadiene, vital to that program!
For this is no ordinary refinery.
It is the first of 31 new plants now under construction in the U.S.A. employing Socony-Vacuum's revolutionary Thermofor Catalytic Cracking Process.
This process gives the Beaumont plant twofold wartime importance—for it not only produces better aviation gasoline in greater quantity—but produces vital raw material for rubber as well!
Its use in the new plants now being built increases the yield per barrel of crude. It saves steel.
Successful operation of this first TCC unit climaxes ten years of pioneering work by the company which was first to recognize the value of catalytic cracking . . . the only method by which 100 Octane gasoline could be produced in the vast quantities needed today.
Thus the TCC Process—developed exclusively by Socony-Vacuum—promises America still more, still better super aviation fuels. And the opening of the Beaumont plant is not only an important step in the winning of the war . . . it promises new "Flying Horsepower" in great quantity for America's peacetime planes and cars!
COMING IN MOBILGAS AFTER THE WAR—
Flying Horsepower
BESIDES HELPING AMERICA to establish lasting supremacy in every theatre of war—by giving our fighters and bombers greater speed, range and hitting power...Flying Horsepower promises U.S. motorists a new and far better gasoline for their cars.
After the war—the same super power proved in war super planes is coming to your Mobilgas. You'll be riding on Flying Horsepower!
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Commercial T.C.C. Unit Now On Stream...

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Evidencing the simplicity and flexibility of operation of the Thermofor Catalytic Cracking Process,* the first commercial T.C.C. unit designed and built by Lummus . . went on stream October 7th.

The start-up operation went off with no difficulties and the performance of the unit is exceeding expectations in regard to yield, quality and catalyst consumption.

The second commercial unit, for another major oil company, went into operation two weeks later.

A number of T.C.C. Reactors are now under construction, some of which are scheduled to go into operation before the end of the year.

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THE WAR-TIME PROCESS WITH THE PEACE-TIME PAYOFF

Field Development

Los Angeles Basin

Deep Test Plugged Back

Standard Oil Co. Murphy-Whittier No. 62, deep test well in the old Whittier field, has been plugged back after drilling to a total depth of 8033 ft. There were no showings worthy of a test found below the known producing horizons in the field. The hole was plugged to 2710 ft. and 8⅝-inch casing cemented at 1300 ft. A 6⅝-inch liner including 6 stages of perforations was landed at 2708 ft. Hole is now being bailed preparatory to placing well on production.

Earthquake Damage Being Repaired

Union Oil Co. is rigging up on Callender No. 75 preparatory to redrilling. This well was originally completed on March 11, 1940, flowing an initial production of 572 barrels per day. Well produced at about 100 barrels per day (under curtailment) until the earthquake killed the flow on October 21, 1941. The 7-inch casing and 2½-inch tubing was found to be collapsed at 5899 ft. The hole was swabbed and well placed back on production October 29, 1941, and has continued producing until recently. The rate of flow had declined to a point where it was no longer economical to produce the well.

El Segundo Gas Well Completed

Standard Oil Co. Gough No. 14 shallow gas test in the old El Segundo field was completed for an initial production of 1,000 m.c.f. per day of dry gas flowing through a 6/64 inch bean. Located near the center of section 7-3s-14w hole was drilled and cored to a total depth of 2310 ft. Five and one-half inch casing was cemented at 2200 ft. and a 4-inch liner including 113 ft. of 30 mesh perforations landed at 2308 ft. A series of flow tests indicate a potential in excess of 5,000 m.c.f. per day. Approximately 600 ft. south of this well, operator has drilled Gough No. 15 to 2330 ft. and is running an electric log prior to setting a five-inch water string.

Inglewood Sentous Zone Extended

Federal Oil Co. Smith No. 4, northwesterly outpost well, was completed November 10 for an initial production of 2950 barrels per day of 34 gravity clean oil. Flowing through a 30/64 inch bean with 1750 pounds tubing pressure and 1800 pounds casing pressure. Located on the southwest corner of Duquesne street and Jefferson Blvd. well was drilled and cored to a total depth of 8329 ft. The Sentous zone was found to be approximately 90 ft. thicker at this location than is found in wells higher on the structure to the south. Some opinions are that this zone should continue across Ballona Creek into the town lot section of Culver City. If this condition exists the producing area of the Sentous zone will be greatly increased.

Deep Test Yet Fishing

Standard Oil Co. Baldwin-Cienega No. 105 deep test well in the Inglewood field has been tied up several days with a fishing job. The present depth of the hole is 9546 ft. No showings of any consequence have been encountered, since a protective string of seven-inch casing was cemented below the Sentous zone at 8495 ft.

Deep Test Continues

The Texas Co. Fields No. D-1 deep test well in the Long Beach field is hung up temporarily while fishing for a drill collar and bit at 9670 ft. Total depth of the hole is now 9694 ft. No cores have been taken to date, however a constant check is being made by frequent runs of the electric log. Try is located southwest of the intersection of Spring and California streets.

LOS ANGELES BASIN WILDCATS

Area	Well	No.	Section	Depth	Status
Aliso Canyon	Barnsdall-Bandini Pet. Co., Roosa	1	29, 3-16		Rig
	Standard Oil Co., Frew	1-2	29, 3-16	3713	Drilling
	Standard Oil Co., Del-Aliso	1	29, 3-16		Grade
Calabasas	Br.-Am. Oil Prod. Co., Coleman	1	25, 1-18	1725	Drilling
Del Valle	Standard Oil Co., N.L. & F.	3-1	19, 4-17	6200	Stdg. cem.
Norwalk	Gen. Pet. Corp., H. B. Allen	1	12, 3-21	9160	Drilling
Pomona	Macmillan Pet.Corp.,Walnut-Creek	1	22, 1-9	610	Drilling
Puente	Horace Steele, Opr., Kenwood	1	17, 2-10	4275	Testing
	Horace Steele, Opr., Kenwood	2	21, 2-10		Location
	J. C. Drilling Co., Kelso	1	12, 2-10	3442	Idle
	Melvin Hansen, Well	2	24, 2-10	1228	Abandoned
Rice Canyon	General Pet. Corp., Mendota	1	22, 3-16	6834	Abandoning
Sylmar	Richfield Oil Corp., T.I.T.	1	19, 3-15	1589	Drilling
Whittier	C.C.M.O. Co., E.Whittier Comm.	1-1	34, 2-11		Rig
	Orange County				
Costa Mesa	Lovelady & Frambes, Destiny	1	9, 6-10	800	Drilling
East Coyote	Barnsdall O.Co.,Sunny Hills Ranch	1	22, 3-10		Grade
Greenville	P. M. Girard, Mark Fisher	1	27, 5-10	5655	Abandoned
Newport Beach	Signal Oil & Gas Co., Banning	2	20, 6-10	3779	Bailing

Brea Olinda Getting Active

Development in this field, one of the oldest in the state, continues at an even pace with work about evenly split between the majors and independents. Fullerton Oil Co. is deepening their old producer No. 16. Located in section 2-3s-10w hole is currently being drilled ahead below 4200 ft. Old total depth 4191 ft. Birch Oil Co. Well No. 17 has been recompleted on the pump for an initial production of 100 barrels of clean oil per day. Hole was plugged to 3900 ft. and the 7-inch casing gun perforated in stages from 2500 ft. to 3750 ft. Located in the same area as the above Fullerton Oil Co. well, hole was originally drilled to the depth of 4504 ft. In the extreme northwest end of the field Shell Oil Co. is preparing to spud their extension test Orange No. 24. Test is located in section 2-3s-10w approximately 700 ft. northwest of the nearest producing well. In the central portion of the field, section 7-3s-9w Union Oil Co. is coring ahead below 3000 ft. in Naranjal No. 16. This operator is grading location for Stearns No. 84 in section 6-3s-9w.

West Coyote Test Shows Promise

Standard Oil Co. Emery No. 73 has 7-inch casing standing cemented over the Emery zone at 5450 ft. Hole is bottomed in poor oil sand and shale at 5915 ft. Operator tested the entire zone in 4 stages. All tests showed a good blow of gas with some clean oil. Only the bottom test, made from 5850 ft. to 5915 ft. showed evidence of water. Operators deep test well, Murphy Coyote No 129, flowed salt water on attempts to complete from the Emery zone. Now trying to secure a shutoff at the base of the sand. Total depth of the hole is 9295 ft.

Barnsdall Deepens At Rosecrans

Barnsdall Oil Co. O'Dea No. 18, located at the northeast corner of Rosecrans Blvd. and Broadway, is being deepened to the Eighth zone. Well was originally completed in December of 1937 for an initial production of 1248 barrels per day. Producing from 350 ft. of O'Dea zone between the depths of 7196 ft. and 7595 ft. Hole was plugged to 6850 ft., from which depth the old hole was sidetracked. At present writing well is being drilled ahead below 8000 ft.

Deep Test Flowing

Rowena No. 1, deep test well of the Southern California Petroleum Corp., is flowing 50 to 60 barrels per day of clean 32 gravity oil. Well is producing from gun perforations in 4¾-inch casing between the depths of 7725 ft. and 7800 ft. Hole was drilled to 8100 ft. and plugged back to 7835 ft. after tests in the eighth zone recovered only salt water. Located in the southeast end of the Rosecrans field, the well was originally completed in February of 1940 for an initial production of 240 barrels per day from the depth of 7465 ft. In May of the same year the flow was killed and hole deepened to 7734 ft. Recompleted on June 4 well tanked 592 barrels during the first 24 hours.

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San Joaquin Valley

Riverdale Extension

Amerada Petroleum Corp. is preparing to drill Furtado No. 55-36 as a southeasterly extension test of the Riverdale field. Try will be located near the center of section 36-17s-19e approximately one and a quarter miles southeast of the nearest producing well. Operator reports Eocene sands as the objective. North of this well in section 16-17s-19e Amerada Pet. completed Young No. 85-16 for an initial production of 200 barrels per day of 38 gravity clean oil. Well is producing from a total depth of 7920 ft. This operator has also staked locations for two additional wells in this field. They will be known as Larrey No. 87-15 and Cerini Unit No. 85-22. The new locations fall in sections 15 and 22 of township 17s, range 19e.

Raisin City Cat Shows Promise

Approximately one mile southeast of the Raisin City field the Pauley Brothers well No. 21-29 is showing promise of being a producer. Located in section 29-15s-18e the well was drilled and cored to a total depth of 4844 ft. Hole was plugged back to 4820 ft. and a formation test made of the zone from 4800 ft. to 4820 ft. The tester was open for thirty minutes and well showed a blow of wet gas at rates estimated from 3,000 to 6,000 m.c.f. Considerable condensate was recovered in the drill pipe. Operator now has cemented 7 inch casing at 4821 ft. and is preparing to gun perforate and place well on production from this zone. Well is reported to be 140 ft. structurally lower than the Shell Oil Co. discovery well in the Raisin City field.

Universal Extends Raisin City Field

Universal Consolidated Oil Company has extended the known producing limits of the Raisin City field approximately one quarter mile to the west. Located in section 14-15s-17e, Taylor No. 1 showed an initial rate of 550 barrels per day of 25 gravity oil cutting 5 per cent water. At present well is flowing 240 barrels per day through an 18/64 inch bean with 1125 pounds tubing pressure and 2300 pounds casing pressure. Gas production is 20,000 cubic feet per day. Total depth is 6312 ft. 7-inch casing was cemented on bottom and gun perforated in three stages between the depths of 6232 ft. and 6312 ft. Top of the Kreyenhagen shale was found at 5939 ft.

Superior Abandons Glenn County Cat

Superior Oil Company Glenn Comm. Three No. 72-20 was abandoned November 15 at a depth of 9179 ft. Try is located in section 31-21n-1w southwest of the company's gas producer, Knight No. 1. Hole was bottomed in basement rocks after running several formation tests on showings up the hole.

Shark Tooth Test Abandoned

Apparently the development of the Shark Tooth field, discovered by the Bandini Pet. Corp., is going to be very costly. To date it remains a one-well field. Bandini Pet. Corp. Signal-Mills No. 2 drilled and cored to a total depth of 3053 ft. in green Walker clay and sandstone. No commercially productive sands were encountered, and the well was abandoned November 14. Operator is now moving in equipment to drill Signal-Mills No. 3. Both wells are located in section 24-28s-28e, about two miles west of the Round Mountain field.

SAN JOAQUIN VALLEY WILDCATS

Area	Well	No.	Section	Depth	Status
	Fresno County				
Coalinga	The Texas Co., S.P.	58-21	21, 19-16	6854	Drilling
	Wilshire Oil Co., Imperial	1	34, 18-15		Location
Jacalitos	Standard Oil Co., Well	67-17E	17, 21-15	2298	Drilling
	Standard Oil Co., Wells Fargo	1	30, 21-15		Location
Jamesan	Amerada Pet. Corp., Mendota	53-12	12, 14-16		Rigging up
Lanare	Superior Oil Co., Maxfield	41-21	21, 17-18	7870	Drilling
Nicholson	Shell Oil Co., Inc., S.P.	73-35	35, 15-15	3951	Drilling
Polvadero	Standard Oil Co., Bourdieu	1A	1, 21-16	9932	Drilling
Raisin City	Pauley, E. W. & H. R., Well	21-29	29, 15-18	4844	Testing
Riverdale	Amerada Pet. Corp., Furtado	55-36	36, 17-19		Location
	Kern County				
Belridge—South	C.C.M.O. Co., Temblor	36-1	36, 28-20		Foundation
Comanche Point	T. W. Burnham, Chiquita	2	34, 12-19	2250	Idle
Cymric	Standard Oil Co., McPhee	37	36, 29-21	7415	Drilling
Edison	Tracy Harkness Seale	2	5, 30-29		Rigging up
	J. Paul Getty, Portals	4	5, 30-29	525	Drilling
	Seaboard Oil Corp., Garrison-Davis	1	30, 29-29		Rigging up
Elk Hills	Capital Co., Tupman	1	24, 30-24		Location
	Pacific Western and G. F. Getty Transport	64	26, 30-24	9265	Drilling
Grapevine	Kern Line Oil Co., Well	1	19, 11-19	9200	Idle
Jasmine	Western Gulf Oil Co., Well	1	4, 25-27		Location
McClung	Continental Oil Co., KCL	H-1	18, 30-26	8272	Drilling
	Continental Oil Co., Easton	1	33, 29-26		Rigging up
McKittrick	Terry, George, Well	1	18, 30-22		Location
	Standard Oil Co., Well	22-35	35, 30-22	250	Drilling
Midway	C.C.M.O. Co., Well	26	1, 32-22	2034	Drilling
Mt. Poso	British-American, Recovery	2	34, 26-28	1309	Completing
	Da-Me Oil Co., Well	4	27, 26-28	1369	Idle
	D. W. Vedder, Well	1-18	18, 27-28	2470	Testing
	D. W. Vedder, Glide	29-3	29, 27-28		Grade
	J. T. Wilcox, Zanetti	1	17, 28-28	2200	Drilling
Mt. View	Di Giorgio Fruit Corp., Well	48-10	10, 21-29	4345	Drilling
Poso Creek	Butler Bros. Oil Co., Butler	1	14, 27-27	1295	Drilling
	Pac. West'n O. Corp., Enas Fee	26A	21, 27-27	2090	Bailing
	Pac. West'n O. Corp., Enas Fee	38A	21, 27-27		Foundation
Rio Bravo	Union Oil Co., Kernco	81-8	8, 29-25	10165	Testing
Round Mt.	Bandini Pet. Corp., Signal Mills	2	24, 28-28	3035	Abandoned
	Bandini Pet. Corp., Signal Mills	3	24, 28-28		Rigging up
	Gen. Pet. Corp., Railroad	2	23, 28-28	2785	Pumping
	Gen. Pet. Corp., Malta	1	14, 28-28	1180	Drilling
	The Texas Co., KCL	1-13	13, 28-28		Location
	Wilshire Oil Co., Hartfield	1	32, 28-29		Grading
Shafter	T.W.A. Oil Co., Shafter Comm.	86-7	7, 28-25		Rigging up
Tehachapi	E. G. Cummings, Poor Boy	1	31, 32-32	1270	Idle
Temblor	B. F. Delanty, Well	69-A-1	36, 29-20	225	Drilling
	Kings County				
Hanford	Seaboard Oil Corp., Phillips	66-2	2, 19-22	6633	Abandoned
	Madera County				
Herminghaus	The Texas Co., Gill	61-20	20, 13-16		Rigging up
	Shell Oil Co., Inc., Gill	38-18	18, 13-16	4507	Drilling
Firebaugh	The Texas Co., Moffat	55-7	7, 12-15		Rig
	Merced County				
Los Banos	Shell Oil Co., Inc., Alberti	75-11	11, 10-11		Rigging up
	Tulare County				
Terra Bella	Richfield Oil Corp., Terra Bella, Comm.	1-1	19, 22-27	2353	Spot coring

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Gulf Working At Fruitvale

Western Gulf Oil Co. is continuing its development program in this field with two strings running simultaneously. In section 27-29s-27e Red Ribbon No. 16 is being drilled ahead below 3400 ft. while in section 22 of the same township and range KCL-A No. 2 is drilling below 3500 ft. Operator has location staked for Neumann No. 1 in section 21 and is swabbing, preparatory to placing Red Ribbon No. 4 on production.

Greeley Outpost Flows Clean Oil

Standard Oil Co. Wegis Comm. No. 1 southeasterly extension well, flowed clean oil at an 800 barrel per day rate. Located in section 21-29s-26e hole was drilled and cored to a total depth of 11,600 ft. Seven-inch casing was cemented at 11,445 ft. and an open hole test made of the Vedder sands from the shoe to bottom. Drill pipe was twisted off while cleaning out preparatory to running a five-inch perforated liner. The completion has been held up for about 10 days while attempting to recover this fish.

North Midway Development

In the extreme north end of the Midway-Sunset field, activities of the major oil companies are proceeding at a rapid pace. General Petroleum Corp., latest to enter the picture, is drilling ahead on Shale No. 40 below 1800 ft. The well is located in section 14-31s-22e. Richfield Oil Corp. in section 11-21s-22e has rig built for Fairfield No. 202 while Fairfield No. 224 is awaiting a crew to pull liner and plug off bottom water. Standard Oil Co. drilled well No. 1-15A in section 15 and is preparing to abandon the hole after bailing tests showed no evidence of either oil or gas. The total depth is 1210 ft. Operator has locations staked for three additional wells in this section. The Texas Co. has just completed well No. 12-6 in section 12, pumping at the initial rate of 16 barrels per day. The total depth is 1827 ft. Well No. 12-7 was spudded November 16 and is currently drilling below 900 ft.

Polvadero Test Getting Deep

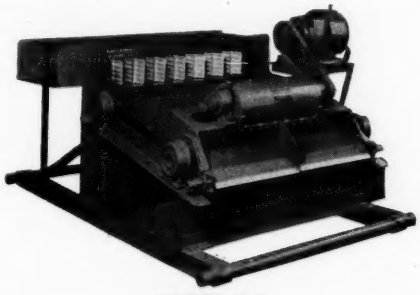
Standard Oil Co. Bourdieu No. 1-A is now in the deep class. Well is currently drilling ahead in hard shale below 10,000 ft. Try is located in section 1-21s-16e, about midway between Kettleman Hills North Dome and the Pleasant Valley Fields. Objective of the test is the McAdams sand which should be encountered in the neighborhood of 11,000 ft.

Capital Co. Locates Elk Hills Test

North of the Elk Hills field the Capital Company has staked location for an extension test which will be known as Tupman No. 1. Well will be drilled in section 24-30s-24e and has sands in the Stevens zone as the objective. At this location these beds will probably not be found above 10,000 feet.

Continental Cat Cores Showings

Continental Oil Co. K.C.L. No. H-1 located in section 18-30s-26e south of the Strand field is coring ahead below 8300 ft. Company is withholding all information on the formation since reporting shaley oil sand at 8230 ft.



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Shell Co. Testing

Shell Oil Co. Marysville Comm. No. C-1, operators second test on its recently acquired Marysville Buttes property, is coring ahead in gray sand and shale below 6100 ft. A formation test was made of some very hard tight sand found between the depths of 4942 ft. and 6000 ft. There was no blow of gas and only 93 ft. of muddy water was recovered in the drill pipe. Test is located in section 12-16n-1e on the north flank of the Marysville gas field.

Standard Resumes At Rio Vista

Standard Oil Co. has resumed operations in the Rio Vista gas field. Location has been staked for Production Properties No. 2 200 ft. south and 800 ft. west from the northeast corner of section 28-3n-3e. This will be the first well drilled by this operator in the Rio Vista field for several months.

Fillmore Cat Getting Deep

Northwest of the town of Fillmore Standard Oil Co. continues to drill ahead in its Fillmore Comm. No. 2-1. Well is currently drilling ahead and taking spot cores at 150-ft. intervals below 10,600 ft. The company is withholding all information as to the section being penetrated. Unofficial sources, however, report recent cores to be siltstone of Pico age. Test is located in section 24-4n-20w.

Monterey Test Doubtful

Royalty Service Corp. Federal No. 1, located in section 21-24s-10e southwest of the town of Bradley, is spot coring ahead in hard Miocene shale below 7300 ft. The operators present plans call for the abandonment of the hole if no showings are encountered above 7500 ft.

Oxnard Tests In Oil Sand

The three wells being drilled in the tar producing area east of the town of Oxnard have all reached the sand. E. F. Delaney Todd No. 1 is drilling ahead in brown shale at 2850 ft. Top of the tar sand was found at 2310 ft. Exeter Oil Co. Lennox No. 2 found the top of the tar sand at 2030 ft. and drilled into volcanics at 2368. With present depth at 2572 ft. operator is fishing for drill pipe which froze when circulation was lost. Hub City Petroleum Co. Chase No. 1 is standing idle at the depth of 1955 ft. Top of the Pico tar sand was found at 1932 ft. All three tests are located in section 6-1n-21w.

Wiley Canyon Test Drilling

In the Wiley Canyon area of Ventura County Wilshire Annex Oil Co. is drilling ahead in its Ventura Realty No. 1. Located in section 1-3n-19w well is making hole in shale with streaks of sand below 1500 ft. Test was spudded November 8 and has 11¾-inch surface casing cemented at 625 ft.

Bardsdale Well Cores Oil Showings

San Marino Oil Co. Elkins No. 1 sec. 7-3n-19w, was last reported coring oil sand and gray sand at 1695 ft. This try is located at the southeast flank of the Bardsdale producing pool.

Purisima Hills Plugging and Testing

Whittier Associates Barham No. 1, sec. 11-7n-32w at East Purisima Hills, is plugging and testing in an effort to isolate and kill water entry which has hampered production of the 14 gravity oil proved present in this hole.

Bottomed at 4847 ft. the well was plugged originally to 3362 ft. to produce a maximum of 60 bbls. daily heavy oil with some 1100 bbls. of water.

COASTAL COUNTIES WILDCATS

Area	Well	No.	Section	Depth	Status
Casmalia	O. C. Field Gas. Corp., Casmite	3	13, 9-35	1850	Rng. liner
Lompoc	Fickert Oil Co., Ltd., Fickert	1	8, 7-33	800	Idle
Los Olivos	Hub Oil Co., La Laguna	1	7, 7-30	3580	Idle
Purisima Hills	Whittier Assoc., Barham	1	11, 7-32	4847	Plugging
Sisquoc	J. I. Anderson, Elliott	1	6, 9-32		Prep. to spud
	Ventura County				
Bardsdale	San Marino Oil Co., Elkins	1	7, 3-19	1695	Drilling
Camarillo	Camarillo Oil Co., Camarillo	2	32, 2-20	1836	Bailing
Del Valle	Herley-Kelley, Black	1	13, 4-18		Grade
Fillmore	Standard O. Co., Fillmore Comm.	2-1	24, 4-20	10618	Drilling
Happy Camp	Cal Camp Oil Corp., Harrington	1	21, 3-19		Location
Oxnard	Edward F. Delaney, Todd	1	6, 1-21	2843	Drilling
	Exeter Oil Co., Ltd., Lennox	2	6, 1-21	2572	Drilling
	Hub City Pet. Co., Chase	1	6, 1-21	1955	Drilling
Piru	Pac. West. Oil Corp., Temescal	17	4, 4-18	1912	Drilling
Santa Paula	J. J. Stevens, Corehole	1	31, 4-20	1809	Drilling
Sespe	Merchants Pet. Co., Cochrane	7	1, 4-20	1399	Drilling
	Volunteer Pet. Co., Tar Creek	3	28, 5-19	1306	Cleaning out
Simi	Mayo Oil Co., Montgomery	1	16, 2-18	993	Drilling
South Mt.	F. E. Fairfield, S. M.	1	19, 3-20	4798	Drilling
Timber Canyon	Henderson-Ortez Oil Co., O'Leary	1	29, 4-20		Rigging up
Torrey Canyon	Union Oil Co., Torrey	60	5, 3-18	6146	Pumping
Wiley Canyon	Wilshire Oil Co., Ventura Realty	1	1, 3-19	1436	Drilling

NORTHERN COUNTIES WILDCATS

County	Well	No.	Section	Depth	Status
Butte	Richfield Oil Corp., Chico	1	17, 21n-1e	6500	Stdg. cem.
Colusa	Gen. Pet. Corp., Capital	1	15, 16n-1w	3180	Drilling
Contra Costa	Cal-Bay Corp., Faria	1	21, 2n-1w	4398	Idle
	Standard Oil Co., Oursan Comm.	1	28, 2n-3w	3452	Drilling
Glenn	Richfield Oil Corp., Afton Comm.	1	2, 18n-1w		Cellar
	Superior Oil Co., Glenn Comm.	72-20	31, 21n-1w	9179	Abandoned
Monterey	Royalty Service Corp., Federal	1	21, 24s-10e	7318	Drilling
Sacramento	Amerada Pet. Corp., Gwerder	1	36, 5n-5e	3799	Testing
San Joaquin	Amerada Pet. Corp., Blossom Comm.	1	32, 5n-5e		Grade
	Richfield Oil Corp., East Stockton	1	5, 1n-8e	3065	Drilling
	Standard Oil Co., Blewett Comm.	3	23, 3s-6e	4015	Drilling
	Standard Oil Co., Fairoaks Comm.	1	19, 1n-7e		Rigging up
San Luis Obispo	Los Nietos Co., Scott	1	5, 31s-13e	3155	Stdg. cem.
Solano	Standard Oil Co., Honker Comm.	1A	25, 3n-1w	8304	Fishing D.P.
	Standard Oil Co., A. O. Stewart	1	25, 3n-1w	7567	Drilling
	Standard Oil Co., Suisun Comm.	3	5, 3n-1w		Location
Sutter	Shell Oil Co., Buttes Comm.	C-1	12, 16n-1e	6099	Drilling
Tehama	Petrol Prod. & Ref. Corp., Donna	1	6, 23n-6w		Location
Yolo	Empire O. & G. Corp., Porterfield	1	18, 10n-2w		Location

Avenue Producers Sustain Field Rates

Ventura Avenue field completions remain substantial after 40 years of commercial operation. First employed to provide gas for the Ventura County Power Co. in 1903 the field now approximates 2500 acres of proven acreage and has been actively developed since 1915.

Deepest producer in the field is Tide Water Assoc. Oil Co. Hartman No. 29 which makes 971 bbls. of 30 gravity oil and 517,000 cu. ft. of gas from the D-6 zone at 11740 ft.

Latest completed are Tide Water's Lloyd No. 149 and McGonigle 19, each producing from the 10,000 ft. level. Also working in the field is Shell Oil Co., Inc., Gen. Pet. Corp., Lloyd Corp., and British-American Oil Prod. Co.

Edna Area Cat Logs Oil Sand

Los Nietos Co. Scott No. 1, sec. 5-32s-13e in San Luis Obispo county, is standing with 7 inch casing cemented over good looking oil sands taken from 3102 ft. to bottom at 3155 ft. If producible, this well proves a long standing contention that production still exists in the Oak Park pool southeast of the Arroyo Grande or Edna field. Production histories in this area are scant, but the Edna field was first produced in 1906 with oil being found at Oak Park as late as 1927 by Elberta No. 1, now abandoned because of mechanical difficulties.

Chico Creek Well Ready to Deepen

Richfield Oil Corp. Chico No. 1, sec. 17-21n-1e, is preparing to prospect ahead from 6500 after cementing casing at 5275 ft. to protect gas sands found producible in the interval 4272-4385 ft. These sands flowed 13,000,000 cu. ft. of gas.

Santa Maria Well Flowing

Hancock of Bush Oil Co. completed Rosenblum No. 5 sec. 25-10n-34w in Santa Marin Valley, at 4578 ft. flowing more than 1500 bbls. daily rate. At last report the well was beaned back to its allowable. The joint operators are under way with Bradley No. 9, on adjacent section 26, which was last reported at 3360 ft.

Bel-Air Oil Co., currently redrilling Twitchell-Weging Comm. No. 2 on sec. 26-10n-34w, plans three immediate wells on the Kate Donovan property, a part of lot 102, Rancho Guadalupe.

Union Oil Co. continues its valley development with two strings at work. Russel No. 5 is finishing at 4825 ft. while Bradley Lands No. 1-7 is making hole at 5387 ft. The company has a series of wells scheduled in advance of the drill.

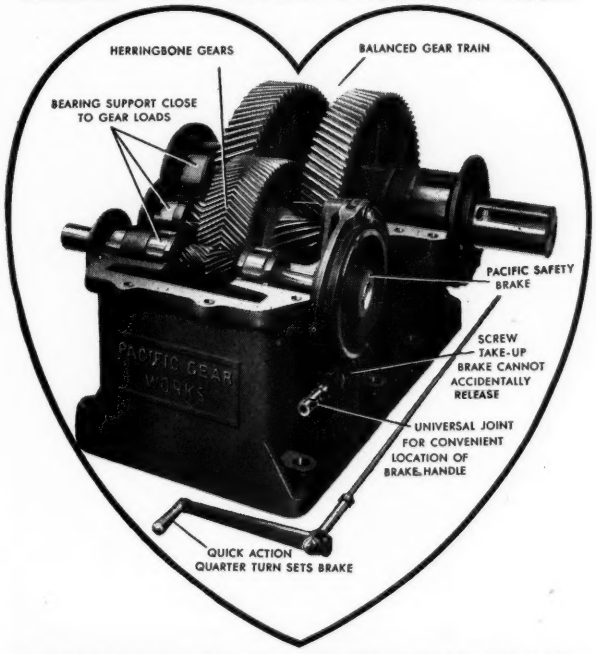
Shiells Canyon Well Produces

The Texas Co. completely Shiells No. 142 on sec. 4-3n-19w at 2623 ft. pumping 82 bbls. daily clean 33.7 gravity oil. Texas is already under way with No. 143, now standing with casing cemented at 1039 ft.

Standard Drills Old Pico Canyon

In the old Pico Canyon field Standard Oil Co. is grading location for a new deep test well which will be known as P.C.O. No. 42. Location reported is 1600 ft. north and 800 ft. east from the southwest corner of section 1-3n-17w. The well will explore below the known producing horizons in the field.

HEART OF A GOOD PUMPING UNIT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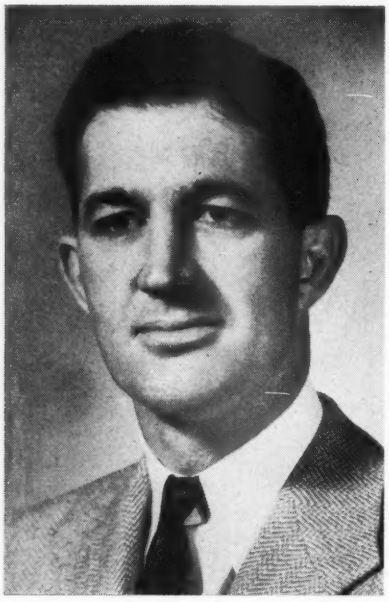
Republic Supply Company Announce Promotions

J. J. Pike
(Elected President)



R. B. Freeman
(Manager of Oilfield Sales)

Robt. L. Temple
(Sales Manager, Industrial Division)

Republic Supply Company of Calif. recently announced the election of J. J. Pike as President, succeeding Walter Duhig, who resigned in October.

Announcement is also made of the appointment of R. B. Freeman as Manager of Oil Field Sales, and of the appointment of Robert L. Temple as Sales Manager, Industrial Division.

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End illustration of the range of diameters and wall thickness in Duraloy Cast Alloy Tubing.

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Thank You, Mr. Jeffers

For Relief in the Rubber Crisis

Thanks for a hard job, well done, as Rubber Director. The American Rubber Manufacturing Company joins its customers in expressing appreciation for this achievement:

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THIS LAUGH

OFF!!

Two recruits from the Atlantic coast were assigned to a camp in California. On their first Saturday's leave, they were gazing across the blue waters of the Pacific.

"Just think," said one of them, "this here Pacific Ocean is over twice as big as the Atlantic."

The second one shaded his eyes and scanned the empty waters diligently. After a moment he spoke. "It sure is," he said.

Rastus and Liza were roller skating when suddenly Liza fell down, but flopped over and came up again with remarkable agility.

"Did you all see how quick Ah recovered mah equilibrium? she asked.

"Ah sho did," replied Rastus, "and almost before Ah noticed it was uncovered."

The two beginners were playing golf. The next green was 300 yards away and over numerous hazards. One shut his eyes and took a lusty swing. By a freak of chance he connected with the ball and sent it sailing for the green. It bounded directly into the cup for a hole-in-one.

"You've made a hole-in-one," exclaimed the other in awed voice.

"I'll wager two-to-one I could do it again," bragged the first.

"Okay," grunted his friend, "It's a wager—but on one condition."

"Sure," agreed the confident one.

"This time," said the other, "you've got to make the shot with your eyes open!"

Soldier: "Say, you think you're a pretty hard guy, don't you?"

Marine: "I am. I wasn't born; I was quarried."

And the mention of eggs reminds us of the Signal Hill pumper whose wife did bird imitations—she watched him like a hawk.

King Solomon and King David
Led merry, merry lives;
They had many, many concubines
And many, many wives.
But when old age stole o'er them,
With all its quakes and qualms,
King Solomon wrote the Proverbs
And King David wrote the Psalms.

Three puppies named Raindrop, Dewdrop and Coughdrop went to play and Mother Dog warned them to be back by noon. Raindrop and Dewdrop came in promptly but Coughdrop was nowhere in sight. Late that night she came in, tail between her legs.

"Coughdrop," called her mother. "Where have you been?"

"I'm not Coughdrop any more," sobbed the puppy. "I'm just an old —another kind of candy."

A drilling contractor, on a business trip to the city, boarded the sleeper and pulled back the curtains of his berth. He was extremely surprised . . . to find two most personable blondes ensconced there.

After checking his ticket to make sure that he wasn't wrong, he said. "I deeply regret this, ladies, but I am a married man . . . a man of respect and standing in my community. I couldn't afford to have any breath of scandal touch me, I'm sorry—but one of you will have to leave.

We're gonna have a swell time tonight, Hon. I've got three seats for the movies.

Three seats? What do we want with three seats?

One for your pop, one for mom, and one for your kid brother.

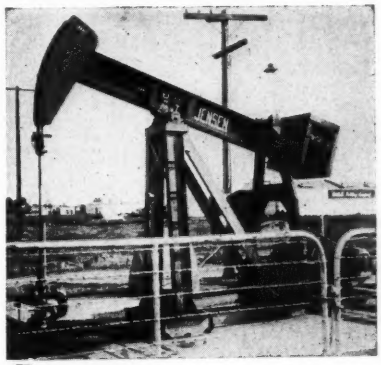
Confucius said: "Aviatrix who fly upside down have bust-up."

"What did father say when you smashed the car?"

"Shall I leave out the swear words?"

"Yes, of course."

"He didn't say a word."



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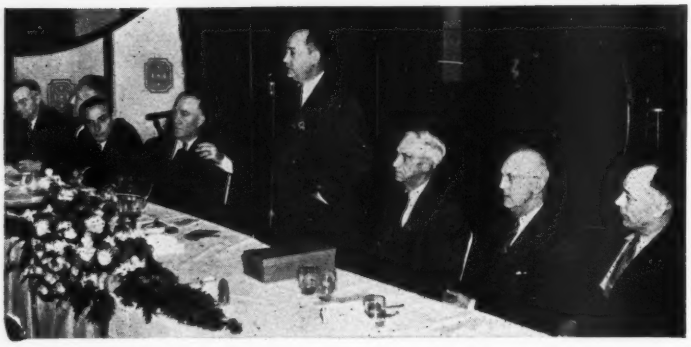

Service Pins Presented By Baker Oil Tools

On October 22, 1943, Baker Oil Tools, Inc., held the Second Annual Service Pin Banquet for its California Division. Left to right above are, R. C. Baker, Jr., S. J. Ralston, G. M. Anderson, E. E. Pyles, Guest Speaker, T. Sutter, R. C. Baker, C. A. McDonald, A. C. Pazdernik. All of the Baker employees pictured are 20-Year Service Men, as are also T. H. Arney, A. A. Baker and A. H. Lake, who were unable to be present. A total of 31 employees were honored with pins representing five years, or more of loyal service.

Eight employees of the Central Division of Baker Oil Tools, Inc. are to receive Service Pins at a similar banquet to be held at Houston on November 19, 1943.

California's first woman rotary helper?

When the manpower shortage struck Huntington Beach, one well known operator proved himself not only fortunate but a super-salesman. Lacking roughnecks and roustabouts he induced his feminine bookkeeper to don hard hat, gloves and work clothes and join the gang at well pulling, bailing, 'etc.' According to his own statements and the observation of this staff-man, she more than pulls her own weight on any job, not even the dirtiest ones quell her willing nature. Pictured here is the paragon of employees, Miss Alma Arterberry, with her employer (left) Boe Tunstall and (right) Leonard Tunstall. Maybe the rest of us are missing bets in meeting "manpower" shortages?

Elk Hills Test Still in Shale

Transport No. 64, northerly extension test to the Elk Hills field, being drilled by the Pacific Western Oil Corporation and Geo. F. Getty, Inc., is drilling ahead in hard shale below 9300 ft. Located in section 26-30s-24e on the north flank of the field, the well is expected to pick up the Stevens sand in the neighborhood of 10,000 ft.

Madera County Test Shows Gas

In the Herminghaus Area of Madera county Shell Oil Co. Gill No. 38-18 is drilling ahead in hard shale below 4500 ft. A short test at 4420-70 ft. blew an estimated 11,000 m.c.f. gas with no oil or water.

Rio Bravo Cat Testing

Union Oil Co. Kernco No. 81-8, wildcat test in section 8-29s-25e approximately two and a half miles southwest of the Rio Bravo field, is plugging back and testing by stages. Hole was drilled and cored to a total depth of 10,165 ft. Heavy gas and oil showings were noted on the ditch from 9680 ft. to bottom. Four tests have been made to date, all showing large amounts of gassy, muddy, oily water with little or no evidence of free oil. At present operator is preparing to make another test of the zone from 5818 ft. to 5823 ft.

Richfield Abandons Tulare County Test

Richfield Oil Corp. Terra Bella Comm. No. 1-1 was abandoned on November 19. The hole was drilled and cored to a total depth of 2353 ft. There were no showings worthy of a test in the entire section penetrated. The well is located in section 19-22s-27e northwest of the town of Terra Bella. The company is preparing to drill another well which will be its third test in this area.

Ring Oil Co. At Dominion

Ring Oil Co. has three projects currently under way in the little Dominion field north of Mount Poso. Located in section 28-26s-28e Vedder No. 3 has been bottomed in oil sand at 1449 ft. and has seven-inch casing standing cemented at 1430 ft. Locations are being prepared for Vedder No. 4 and 5 in this same section.

Pleasant Valley Test in Oil Sand

Robert S. Lytle Well No. 3-28F located in section 28-30s-16e drilled through the oil sand and has been bottomed in sandstone at 9150 ft. The operator now running an electric log preparatory to setting a string of casing. In this same section Standard Oil Co. is making a shut-off test on casing cemented over the Eocene sands. Depth of the hole is 8962 ft. with 8⅝ in. casing cemented at 8941 ft. North of this well, in section 21, operator has staked location for a new well which will be called PVF No. 5-21F.

E. L. Decker Makes Mid-Continent Trip

E. L. Decker, Vice-President of Martin-Decker Corporation, Long Beach, California, has just completed a sales trip in the interests of his company. Kansas, Oklahoma, and Texas were visited and considerable time was spent in West Texas.

ADVERTISING

UNITED STATES DEPARTMENT OF THE INTERIOR, General Land Office, Washington, D. C. Pursuant to Executive Order No. 9236, April 7, 1943 (8 F. R. 4683), notice is hereby given that there is offered for lease in one panel the deposits of oil and gas contained in the land and land under water, within the known geologic structure of the Wilmington oil field, described as follows: A tract of land 600 feet wide known as the Cerritos Channel, lying partly within the corporate limits of the City of Los Angeles and partly within the corporate limits of the City of Long Beach, County of Los Angeles, State of California, and more particularly described as follows: Beginning at Station 13 of the "Inner Bay Exception" of the United States Patent to the Rancho San Pedro, said Station 13 also being U. S. Engineers Station 408; thence, N. 33° 51' W., 631.32 feet along the line of said "Inner Bay Exception" to a point; thence, N. 74° 16' 41" E., 6,905.55 feet to a point, said point being S. 18° 48' W., 18.24 feet from Station 36 of the San Pedro Rancho and Los Cerritos Compromise line; thence, leaving said Compromise line S. 14° 52' 20" E., 500 feet to a point; thence, N. 88° 20' 10" W., 300 feet to Station 35 of the San Pedro Rancho and Los Cerritos Compromise line; thence, S. 48° 42' E., 228.21 feet to a point on said Compromise line; thence, S. 74° 16' W., 6,552.31 feet to the point of beginning containing 92.64 acres, more or less. The parcel is offered for lease to the qualified bidder of the highest bonus per acre, at a total annual rental of $93 and a royalty of 16 2/3 percent, and upon the terms and conditions set forth in the lease form (CC) available for inspection at this office, the district land office and the office of the oil and gas supervisor, Geological Survey, at Los Angeles. Sealed bids, marked outside. "Bids for oil and gas lease, Cerritos Channel," will be received in the office of the Secretary of the Interior until 10 a.m. ,December 13, 1943. Each bid must be accompanied by a certified check on a solvent bank in favor of the Treasurer of the United States, or cash equal to one-fifth of the bonus bid, together with a showing of qualifications to receive such lease required by 43 Code of Federal Regulations, 192.19. The successful bidder must pay the remainder of his bonus bid and the first year's rental and file a lease bond in the sum of $25,000 prior to the issuance of the lease. The deposits of the other bidders will then be returned. Bidders are warned against violating section 59, United States Criminal Code, prohibiting unlawful combination or intimidation of bidders. The right is reserved to waive technical defects and to reject any or all bids in the discretion of the Secretary of the Interior. The bonus bid and all moneys received as rentals and royalties under the lease, or otherwise, for oil and gas extracted from the land will be deposited in a special trust fund in the Treasury, under 31 U.S.C. sec. 725r, pending the final judgment in the case of *United States* v. *Los Angeles and Salt Lake Railroad Company*, No. 2009-Y Civil, United States District Court, Southern District of California. The defendant has appealed from the District Court's decision sustaining the Government's title to these deposits. The lessee's operations will be subject to the jurisdiction of the War Department over the channel for flood-control and navigation purposes. There is on file in each of the above offices a copy of a map, dated October 16, 1943, showing the areas in the channel where the War Department will permit the installation of drilling rigs under present conditions, but no surface well structure may be located more than 50 feet channelward of the 600 foot property line and a separate permit will have to be obtained from the War Department for the location and construction of each structure. Drilling may be conducted from sites outside the leased area, but the lessee will have to acquire at his own expense any land to be used for such purposes. The lessee will also have to acquire any drilling sites needed if sufficient sites are not available within the leased area but the Secretary of the Interior will waive this requirement in any instance where the lessee, in good faith, is unable to acquire such a site. The lessee will be required to begin drilling within 60 days from the date of the delivery of the lease and to continue drilling with reasonable diligence until there have been drilled to production within 12 months from delivery of the lease 10 wells in the Terminal or Ranger zones, and a total of 16 wells in said zones within 18 months of delivery, but the Secretary, in writing may consent to the drilling of a lesser number of wells. The lessee may propose, for the approval of the Secretary, a unit plan for the consolidated operation of adjoining lands and the lands to be leased hereunder, which plan may provide, among other things, for the drilling of only such wells as may be necessary to drain effectively these deposits. The lessee shall not discriminate against any employee or applicant for employment because of race, creed, color, or national origin, and shall require an identical provision to be included in all subcontracts. Commissioner, General Land Office.

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U. S. Steel Products Co. Announces Organization Changes

John Hauerwaas, newly-appointed president of United States Steel Products Company, formerly Boyle Manufacturing Company, recently made announcement regarding organization changes in this U. S. Steel subsidiary, including appointments to executive positions.

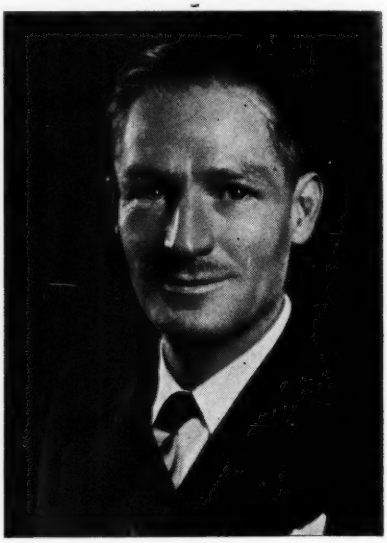
The plants formerly operated by Boyle Manufacturing Company are now operated by the Boyle Manufacturing Division of U. S. Steel Products Company. The plants recently acquired from the Petroleum Iron Works Company near Sharon, Pennsylvania and at Beaumont, and Port Arthur, Texas, are now operated by the Petroleum Iron Works Division of U. S. Steel Products Company.

The appointments announced were those of T. McGahan, as Vice President and General Manager of Sales and A. E. Klieves as Vice President in Charge of Operations, Boyle Manufacturing Division. At the same time, J. A. Connelly was appointed Vice President and General Manager of the Petroleum Iron Works Division and William I. Hanrahan, Vice President of the same division.

Temporary executive offices will be established by the U. S. Steel Products Company at 30 Rockefeller Plaza, New York City.

John Hauerwaas

T. McGahan



A. E. Klieves

Spang Chalfant Makes Changes in Field Organization

Spang-Chalfant, Pittsburgh, Pennsylvania, announces as of November 1, 1943, the following changes in its field organization:

Mr. H. G. Texter will return to his former headquarters, Tulsa, Oklahoma, to resume his activities as Chief Field Engineer.

Mr. George M. Eaton, who for many years represented the company as Field Engineer in California, with headquarters at Los Angeles, is retiring and will be succeeded by Mr. James A. Kennedy, who is being transferred from Tulsa, Oklahoma, to Los Angeles.

Mr. N. A. Rebarick, who during the past several years has held various positions in the Operating Department at the company's Seamless Tube Mill, Ambridge, Pennsylvania, will succeed Mr. Kennedy as Field Engineer with headquarters at Tulsa, Oklahoma.

New Personnel Appointments at Gardner-Denver Company

R. H. Rodolf has been appointed manager of the Pump and Compressor Division of Gardner-Denver Company, Quincy, Illinois, following the death of R. J. MacFarland. Mr. Rodolf's connection with the company dates back to August, 1917 when he joined the Canadian Rock Drill Company at Vancouver, B. C., then a subsidiary of the Denver Rock Drill Manufacturing Company of Denver, Colorado. In 1926, Mr. Rodolf was transferred to the St. Louis office as district manager. He continued in that capacity after the merger of the Gardner Governor Company and the Denver Rock Drill Manufacturing Company and was transferred to Quincy in 1939 as assistant manager of the Portable Compressor and Rock Drill Division.

Appointed as Mr. Rodolf's assistant is C. M. George, who joined the Gardner-Denver organization in Quincy in January, 1929. With the exception of a few months spent in the armed forces with the U. S. Engineers, Mr. George's service with Gardner-Denver has been continuous in Quincy. Up to his recent appointment as assistant manager of the Pump and Compressor Division, Mr. George had been connected with the General Sales Department of the Gardner-Denver Company.

Wildcat Christmas Jinks

Wednesday, December 15, has been selected as the date for the Annual Christmas Jinks of the Wildcat Committee of the California Oil and Gas Association. It will be a benefit function, the net proceeds of which will be devoted to the Arts and Skills program for Convalescent Servicemen, to be administered by the Los Angeles Chapter, American Red Cross. The affair will be held in the Biltmore Bowl. Arrangements are being made for an outstanding show of top-notch artists.